REJ10B0210-0400

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SuperH™ RISC engine Simulator/Debugger

User's Manual

Renesas Microcomputer Development Environment System

User's Manual

Rev.4.00
Revision Date: Jul. 25, 2007

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Document Information

Product Code: S32HEWM
Version:

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About This Manual

This manual describes the HEW system. This manual is composed of two parts. HEW part describes information on the basic “look and feel” of the HEW and customizing the HEW environment and detail the build. Figure in the HEW part are those of the SH series. Simulator/Debugger part describes Debugger functions of the High-performance Embedded Workshop.

This manual does not intend to explain how to write C/C++ or assembly language programs, how to use any particular operating system or how best to tailor code for the individual devices. These issues are left to the respective manuals.

Document Conventions

This manual uses the following typographic conventions:

Table 1 Typographic Conventions

Convention	Meaning
[Menu->Menu Option]	Bold text with ‘->’ is used to indicate menu options (for example, **[File->Save As...]**).
FILENAME.C	Uppercase names are used to indicate filenames.
“enter this string”	Used to indicate text that must be entered (excluding the “” quotes).
Key + Key	Used to indicate required key presses. For example, **CTRL+N** means press the **CTRL** key and then, whilst holding the **CTRL** key down, press the **N** key.
➲ (The “how to” symbol)	When this symbol is used, it is always located in the left hand margin. It indicates that the text to its immediate right is describing “how to” do something.

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Section 1 Overview

The simulator/debugger is a powerful development environment tool for embedded applications running on Renesas Technology microcomputers.

The simulator/debugger is used with the High-performance Embedded Workshop (HEW). The HEW provides a graphical user interface that eases the development and debugging of applications written in the C/C++ programming languages or assembly language for Renesas Technology microcomputers. Its aim is to provide a powerful yet intuitive way of accessing, observing and modifying the debugging platform on which the application is running.

READ the simulator/debugger and HEW help information before using the simulator/debugger.

Section 2 Simulator/Debugger Functions

This section describes the functions of the SuperH™ RISC engine simulator/debugger.

2.1 Features

- Since the simulator/debugger runs on a host computer, software debugging can start without using an actual user system, thus reducing overall system development time.
- The simulator/debugger provides pseudo-interrupt and I/O-simulation functions for simple system-level simulation.
- The simulator/debugger offers the following functions that enable efficient program testing and debugging.
  - The ability to handle all of the SuperH™ RISC engine series CPUs
  - Functions to stop or continue execution when an error occurs during user program execution
  - Profile data acquisition and function-unit performance measurement
  - A comprehensive set of break functions
  - Functions to set or edit memory maps
  - Functions to display function call history
  - Coverage information is displayed in the C/C++ or assembly-source level
  - Visual debugging functions provided through the display of memory contents as images or waveforms
- The breakpoints, memory map, performance, and trace can be set through the dialog boxes under Windows®. Environments corresponding to each memory map of the SuperH™ RISC engine microcomputers can be set through the dialog box.
  - Intuitive user interface
  - Online help
  - Common display and operability

2.2 Target User Program

Load modules in the Elf/Dwarf2 format can be symbolically debugged with the simulator/debugger. Load modules in other formats can be downloaded, and their instructions can be executed; however, they cannot be symbolically debugged. For details, refer to section 17.18.2, Elf/Dwarf2 Support in the High-performance Embedded Workshop V.4.03 User's Manual.

2.3 Range of Simulation

(1) The simulator/debugger provides simulation functions for the SuperH™ RISC engine series (SH-1, SH-2, SH-2E, SH-3, SH-3E, SH2-DSP, SH3-DSP, SH-4, SH2A-FPU, and SH-4A series) microcomputers.

(2) The SH2-DSP series consists of the SH2-DSP (Core), the SH2-DSP (SH7410), and the SH2-DSP (SH7065) which do not have cache, and the SH2-DSP (SH7612) which has on-chip cache. In this manual, the SH2-DSP series refers to the SH2-DSP (Core), the SH2-DSP (SH7410), the SH2-DSP (SH7065), and the SH2-DSP (SH7612).

(3) The SH3-DSP series consists of the SH3-DSP (Core) and the SH3-DSP; these two types have different DSP functions. In this manual, the SH3-DSP series refers to the SH3-DSP (Core) and the SH3-DSP.

(4) The SH-4 series consists of two types of microcomputers, SH-4 and SH-4 (SH7750R), which have different cache specifications. In addition, the SH-4 has two different versions of microcomputers; one improves the simulation speed by limiting part of the simulation functions (called SH-4 in this manual) and the other provides high-level functions (called SH-4BSC in this manual). Note that in this manual, the SH-4 series refers to the SH-4, the SH-4BSC, and the SH-4 (SH7750R).

(5) The SH-4A series consists of the SH4AL-DSP that incorporates the DSP, and the SH-4A that incorporates the FPU. The extended version is not supported. In this manual, the SH-4A series refers to the SH4AL-DSP and the SH-4A.

(6) Pipeline simulation is supported for the SH-1, SH-2, SH-2E, SH-3, SH-3E, SH2-DSP, SH3-DSP, and SH-4 series microcomputers. As well as pipeline simulation, a further type of debugging target platform is available for the SH3-DSP and SH-4 microcomputers: a functional simulator that supports instruction-unit simulation. Inclusion of "Functional Simulator" in the name of the debugging target indicates this kind of target. In a functional simulator, the number of executed instruction cycles is calculated on the assumption that each instruction is executed in one cycle.

(7) The SH-4A series and SH2A-FPU microcomputers have two types of debugger target. Inclusion of "Cycle Base Simulator" in the debugger target name indicates support for pipeline simulation while the inclusion of "Functional Simulator" indicates support for instruction-unit simulation. In a functional simulator, the number of executed instruction cycles is calculated on the assumption that each instruction is executed in one cycle. In a cycle-based simulator, the number of executed instruction cycles is calculated according to the contents of a table that defines the internal operation of instructions and the state of usage of resources such as registers as a result of instruction-set level simulation. The number of cycles, however, still might not match the result on the actual device. To figure out the exact number of execution cycles (execution time), we recommend that you use the actual device on the emulator or evaluation board.

(8) The simulator/debugger supports the following SuperH™ RISC engine series microcomputer functions:

- All CPU instructions
- Exception processing
- Registers
- All address space
- Peripheral functions shown in table 2.1

Table 2.1 Simulator/Debugger Functions and Corresponding CPUs

Names of Debugging Platforms	Endian	MMU	Cache	Register	BSC	DMAC	Timer
SH-1	—	—	—	—	—	—	△
SH-2	○	—	—	—	—	—	△
SH-2E	—	—	—	—	—	—	△
SH-3	○	○	○	○	—	—	△
SH-3E	○	○	○	○	—	—	—
SH3-DSP	○	○	○	○	—	—	△
SH3-DSP Functional Simulator	○	—	○	○	—	—	△
SH3-DSP (Core)	○	○	○	○	—	—	△
SH-4	○	○	○	○	△	—	△
SH-4 Functional Simulator	○	—	○	○	—	—	△
SH-4BSC	○	○	○	○	○	○	△
SH-4 (SH7750R)	○	○	○	○	△	—	△
SH2-DSP (SH7410)	—	—	—	—	—	—	—
SH2-DSP (Core)	—	—	—	—	—	—	△
SH2-DSP (SH7065)	○	—	—	—	—	—	△
SH2-DSP (SH7612)	○	—	○	○	—	—	—
SH-2A-FPU	—	—	○	○	—	—	△
SH-4A	○	○	○	○	—	—	△
SH-4AL-DSP	○	○	○	○	—	—	△

Note: ○: Supported
—: Not supported
△: Partly supported

(9) The simulator/debugger does not support the following SuperH™ RISC engine series MCU functions. Programs that use these functions must be debugged with the SuperH™ RISC engine series emulator.
- Serial communication interface (SCI)
- I/O ports

(10) The SH2A-FPU supports register banks that allow fast save/restore operations in interrupt processing. Up to 15 register banks (banks 0 to 14) are supported.

2.4 Functions Supported by SH-4 Series

2.4.1 Bus State Controller (BSC)

For the SH-4BSC, the simulator/debugger has the functions for specifying and modifying the memory map in accordance with the BSC setting so that a user program using the BSC can be debugged.

For the SH-4 and SH-4 (SH7750R), the simulator/debugger does not support the bus control function in the BSC, only SRAM, bus width, and the number of states can be specified.

Table 2.2 is a list of memory types that can be specified for the SH-4BSC, SH-4, and SH-4 (SH7750R).

Table 2.2 Memory Types for SH-4BSC, SH-4, and SH-4 (SH7750R) Simulator/Debugger

Address	Specifiable Memory Types	
	SH-4BSC	SH-4/SH-4 (SH7750R)
H'00000000 to H'03FFFFFF (area 0)	Normal memory, burst ROM, and MPX	SRAM
H'04000000 to H'07FFFFFF (area 1)	Normal memory, byte control SRAM, and MPX	
H'08000000 to H'0BFFFFFF (area 2)	Normal memory, DRAM, SDRAM, and MPX	
H'0C000000 to H'0FFFFFFF (area 3)	Normal memory, DRAM, SDRAM, and MPX	
H'10000000 to H'13FFFFFF (area 4)	Normal memory, byte control SRAM, and MPX	
H'14000000 to H'17FFFFFF (area 5)	Normal memory, burst ROM, and MPX	
H'18000000 to H'1BFFFFFF (area 6)	Normal memory, burst ROM, and MPX	
H'1C000000 to H'1FFFFFFF (area 7)	Cannot be specified	
H'7C000000 to H'7C001FFF	Internal RAM (cannot be changed)	
H'E0000000 to H'FFFFFFFF	I/O (cannot be changed)	

The high-order three bits of the addresses for areas 0 to 7 in table 2.2 must be ignored; H'00000000 and H'20000000 are both in area 0.

The simulator/debugger does not support the PCMCIA interface.

For details on settings of memory mapping, refer to section 3.2.2, Modifying the Memory Map and Memory Resource Settings.

2.4.2 Direct Memory Access Controller (DMAC)

For the SH-4BSC, the simulator/debugger simulates the 4-channel DMAC operations; the user program using the DMAC can be debugged.

For the SH-4 and SH-4 (SH7750R), the DMA function cannot be used.

2.5 External/Internal Clock Ratio

The external/internal clock ratio is 1:1. This can be modified by the CLOCK_RATE command only for the SH-4 series. For details on the CLOCK_RATE command, refer to the help information of the simulator/debugger.

2.6 Endian

In the SH-2 series, SH-3, SH-3E, SH3-DSP series, SH-4 series, SH-4A series, SH2-DSP (SH7065), and SH2-DSP (SH7612), the byte order according to little endian as well as big endian can be specified as the data allocation format in the memory. This enables a user program created in the little endian format to be simulated and debugged.

Specify the endian when selecting the debugging platform. When "(Little endian)" is added to the platform name, it indicates little endian (otherwise big endian).

The specified endian is valid for all accesses to external memory. It is also valid for accesses to the X or Y memory with the SH3-DSP series, the L memory with the SH-4A series, and the X, Y, or U memory with the SH4AL-DSP series. Word or longword data is written to or read from the memory in the specified byte order.

Note: The specified endian is applied to all accesses to external memory in common. The SH2-DSP (SH7612) and SH2-DSP (SH7065) have the function to specify endian in memory area units, but the simulator/debugger does not support this function.

2.7 Memory Management Unit (MMU)

For the SH-3, SH-3E, SH3-DSP series, SH-4 series, and SH-4A series, the simulator/debugger simulates MMU operations such as TLB operations, address translation, or MMU-related exceptions (TLB miss exception, TLB protection exception, TLB invalid exception, and initial page write exception). The user program using address translation by the MMU can thus be simulated and debugged. In addition, the MMU-related exception handler routines can be simulated and debugged. The MMU functions differ depending on the CPU.

SH-3, SH-3E, and SH3-DSP Series:

The following window and dialog boxes are provided to manipulate the 32-entry 4-way TLB contents.

- TLB window: Displays and flushes the TLB contents
- TLB item modify dialog boxes: Modifies the TLB items
- TLB item find dialog boxes: Searches for the TLB items

For details, refer to section 3.11, Viewing the TLB Contents.

The TLB is mapped in the range of addresses H'F2000000 to H'F3FFFFFF (all entries of the TLB are allocated within this range).

Note: The SH3-DSP functional simulator and SH3 functional simulator do not simulate MMU operations.

SH-4 Series and SH-4A Series:

The following windows and dialog boxes are provided to manipulate the 4-entry instruction TLB and 64-entry unified TLB contents:

- Instruction TLB window: Displays and flushes the instruction TLB contents
- Unified TLB window: Displays and flushes the unified TLB contents
- TLB item modify dialog boxes: Modifies the TLB items
- TLB item find dialog boxes: Searches for the TLB items

In the SH-4A, the following window is also provided to manipulate the 16-entry instruction PMB contents:

- PMB window: Displays and flushes the PMB contents

For details, refer to section 3.11, Viewing the TLB Contents.

The simulator/debugger does not support data array 2 for both the instruction TLB and unified TLB.

As well as during simulation, the MMU translates virtual addresses into physical addresses during address display or input in the dialog boxes or windows. Therefore, in the dialog boxes and windows, memory can be accessed with the virtual addresses used in the user program. Note, however, that physical addresses must be used in [Memory map] and [System memory resource].

Notes: 1. If an associative write to a TLB entry is performed using the [Memory] window, the entry may not be modified correctly. In this case, use the [Edit] dialog box in the longword format. To open the [Edit] dialog box in the longword format, open the [Memory] window in the longword format and double-click the data to be modified.
2. Some devices do not incorporate the PMB.
3. The SH-4 functional simulator does not simulate MMU operations.

2.8 Cache

For the SH-3, SH-3E, SH3-DSP series, SH-4 series, SH2A-FPU series, SH-4A series, and SH2-DSP (SH7612), the simulator/debugger simulates cache operations and displays the cache contents and cache hit rate. This allows cache operations to be monitored during user program execution. The cache contents differ depending on the CPU.

2.8.1 Displaying Cache Contents

SH-3, SH-3E, SH3-DSP Series, and SH2-DSP (SH7612):

The following window and dialog boxes are provided to manipulate the cache contents:

- Cache window: Displays and flushes the cache contents
- Cache item modify dialog boxes: Modifies the cache items
- Cache item find dialog boxes: Searches for the cache items

For the SH-3 and SH-3E series, the [Cache Capacity] dialog box enables the cache capacity to be specified. This function is unique to this simulator/debugger. Half of the cache can be specified as the internal RAM. Table 2.3 shows the cache capacity and the ways to be used.

Table 2.3 Specifiable Cache Capacity for SH-3 and SH-3E Series Simulator/Debugger

Cache Capacity	Ways to Be Used	Internal RAM Specification (Ways that Can Be Used as Internal RAM)
8 Kbytes	Ways 0 to 3	Ways 2 and 3 can be used as internal RAM
4 Kbytes	Ways 0 and 1	Way 1 can be used as internal RAM
2 Kbytes	Way 0	No way can be used as internal RAM (internal RAM specification is ignored)

For details, refer to section 3.12, Viewing the Cache Contents.

The cache is mapped in the range of addresses H'F0000000 to H'F1FFFFFF in the SH-3, SH-3E, and SH3-DSP series. In the SH2-DSP (SH7612), the address array is mapped in the range of addresses H'60000000 to H'7FFFFFFF, and the data array is mapped in the range of addresses H'C0000000 to H'C0000FFF.

SH-4 and SH-4BSC:

The simulator/debugger simulates operations of the 8-kbyte instruction cache, the 16-kbyte operand cache, and two 32-byte store queues (SQ). The following windows and dialog boxes are provided to manipulate the cache contents:

- Instruction cache window: Displays and flushes the instruction cache contents
- Operand cache window: Displays and flushes the operand cache contents
- Cache item modify dialog boxes: Modifies the cache items
- Cache item find dialog boxes: Searches for the cache items

For details, refer to section 3.12, Viewing the Cache Contents.

The instruction cache is mapped in the range of addresses H'F0000000 to H'F1FFFFFF, the operand cache is mapped in the range of addresses H'F4000000 to H'F5FFFFFF, and the SQ is mapped in the range of addresses H'E0000000 to H'E3FFFFFF.

Note: If an associative write to a cache entry or modification of a cache address array is performed by using the [Memory] window, the entry or array may not be modified correctly. In this case, use the [Edit] dialog box in the longword format. To open the [Edit] dialog box in the longword format, open the [Memory] window in the longword format and double-click the data to be modified.

The simulator/debugger does not change the high-order three bits of the address tag stored in a cache address array to zeros.

When loading a program to the area where the cache is mapped by using the [Load Object File] dialog box or by copying memory data to this area via the [Copy Memory] dialog box, clear the AT bit of the MMUCR to zero to disable the MMU.

SH-4 (SH7750R):

The simulator/debugger simulates operations of the 16-kbyte instruction cache, the 32-kbyte operand cache, and two 32-byte store queues (SQ). The following windows and dialog boxes are provided to manipulate the cache contents:

- Instruction cache window: Displays and flushes the instruction cache contents
- Operand cache window: Displays and flushes the operand cache contents
- Cache item modify dialog boxes: Modifies the cache items
- Cache item find dialog boxes: Searches for the cache items

For details, refer to section 3.12, Viewing the Cache Contents.

The instruction cache is mapped in the range of addresses H'F0000000 to H'F1FFFFFF, the operand cache is mapped in the range of addresses H'F4000000 to H'F5FFFFFF, and the SQ is mapped in the range of addresses H'E0000000 to H'E3FFFFFF.

Note: If an associative write to a cache entry or modification of a cache address array is performed by using the [Memory] window, the entry or array may not be modified correctly. In this case, use the [Edit] dialog box in the longword format. To open the [Edit] dialog box in the longword format, open the [Memory] window in the longword format and double-click the data to be modified.

The simulator/debugger does not change the high-order three bits of the address tag stored in a cache address array to zeros.

When loading a program to the area where the cache is mapped by using the [Load Object File] dialog box or by copying memory data to this area via the [Copy Memory] dialog box, clear the AT bit of the MMUCR to zero to disable the MMU.

SH2A-FPU Series:

The simulator/debugger for the SH2A-FPU simulates the operation of the instruction cache, operand cache, and ROM cache. The following windows and dialog boxes are provided for the manipulation of cache contents:

- Instruction cache window: Displays and flushes the contents of the instruction cache.
- Operand cache window: Displays and flushes the contents of the operand cache.
- ROM prefetch cache window: Displays and flushes the contents of the ROM prefetch cache.
- ROM prefetch miss cache window: Displays and flushes the contents of the ROM prefetch miss cache.
- ROM operand cache window: Displays and flushes the contents of the ROM operand cache.
- Modify cache dialog box: Modifies cache entries.
- Find cache dialog box: Searches for cache entries.

The [Cache Capacity] dialog box enables specification of the cache capacity. Table 2.4 shows the cache type and the cache capacity.

Table 2.4 Specifiable Cache Capacity for SH2A-FPU Simulator/Debugger

Cache Type	Cache Capacity
Instruction cache	8 Kbytes
	16 Kbytes
	32 Kbytes
	64 Kbytes
	128 Kbytes
	256 Kbytes
	512 Kbytes
	1 Mbyte
Operand cache	8 Kbytes
	16 Kbytes
	32 Kbytes
	64 Kbytes
	128 Kbytes
	256 Kbytes
	512 Kbytes
	1 Mbyte

For details, refer to section 3.12, Viewing the Cache Contents.

The address array and data array of the instruction cache are mapped to the ranges of addresses H'F0000000 to H'F07FFFFF and H'F1000000 to H'F17FFFFF, respectively. The address array and data array of the operand cache are mapped to the ranges of addresses H'F0800000 to H'F0FFFFFF and H'F1800000 to H'F1FFFFFF, respectively.

Notes: 1. If an associative write to a cache entry or modification of a cache address array is performed by using the [Memory] window, the entry or array may not be modified correctly. In this case, use the [Edit] dialog box in the longword format. To open the [Edit] dialog box in the longword format, open the [Memory] window in the longword format and double-click the data to be modified.

2. If you attempt to change instruction-cache enabled data via the [Disassembly] or [Memory] window, only the external memory content is updated; the actual instruction-cache data are not affected. To change instruction-cache enabled data, disable the instruction cache beforehand.

SH-4A Series:

The simulator/debugger simulates operations of the instruction cache and the operand cache. With the SH-4A, level-2 cache and two 32-byte store queues (SQ) are simulated. The following windows and dialog boxes are provided to manipulate the cache contents:

- Instruction cache window: Displays and flushes the instruction cache contents
- Operand cache window: Displays and flushes the operand cache contents
- Level-2 cache window (SH-4A only): Displays and flushes the level-2 cache contents
- Cache item modify dialog boxes: Modifies the cache items
- Cache item find dialog boxes: Searches for the cache items

The [Cache Capacity] dialog box enables the cache capacity to be specified. This function is unique to this simulator. Table 2.5 shows the cache type and the cache capacity.

Table 2.5 Specifiable Cache Capacity for SH-4A and SH4AL-DSP Simulator/Debugger

Cache Type	Cache Capacity
Instruction cache	8 Kbytes
	16 Kbytes
	32 Kbytes
	64 Kbytes
	128 Kbytes
Operand cache	8 Kbytes
	16 Kbytes
	32 Kbytes
	64 Kbytes
	128 Kbytes
Level-2 cache (SH-4A only)	128 Kbytes
	256 Kbytes
	512 Kbytes
	1 Mbyte

For details, refer to section 3.12, Viewing the Cache Contents.

The instruction cache is mapped in the range of addresses H'F0000000 to H'F1FFFFFF and the operand cache is mapped in the range of addresses H'F4000000 to H'F5FFFFFF. For the SH-4A, the level-2 cache is mapped in the range of addresses H'F8000000 to H'F9FFFFFF and the SQ is mapped in the range of addresses H'E0000000 to H'E3FFFFFF.

Notes: 1. If an associative write to a cache entry or modification of a cache address array is performed by using the [Memory] window, the entry or array may not be modified correctly. In this case, use the [Edit] dialog box in the longword format. To open the [Edit] dialog box in the longword format, open the [Memory] window in the longword format and double-click the data to be modified.
2. Some devices do not incorporate the level-2 cache.

When loading a program to the area where the cache is mapped by using the [Load Object File] dialog box or by copying memory data to this area via the [Copy Memory] dialog box, clear the AT bit of the MMUCR to zero to disable the MMU.

2.8.2 Cache Hit Rate

Checking and Displaying the Cache Hit Rate: The simulator/debugger acquires the rate of the number of cache hits count to the cache access count as the cache hit rate. The cache hit rate is displayed in percentage in the [Platform] sheet in the [Status] window. The cache hit rate is obtained by dividing the cache hit count by the cache access count (the sum of the cache hit count and cache miss count).

The cache hit count and cache miss count are also displayed.

Initializing the Cache Hit Rate: The displayed cache hit rate is initialized when the simulator/debugger is initiated, the pipeline is reset, or the CCR control register value is modified. In the SH3-DSP series, the cache hit rate is initialized also when the CCR2 control register value is modified.

2.9 Timer

2.9.1 Supported Range

The simulator/debugger only supports channel 0 of each timer.

In addition, the simulator/debugger also supports interrupts by an overflow, underflow, or compare match, but does not support functions with the input and output of the pin such as the input capture.

2.9.2 Control Registers

This simulator/debugger supports timer control registers. Table 2.6 shows the control registers supported by the simulator/debugger.

The addresses of the timer control registers, interrupt vector numbers, and positions of the interrupt priority registers can be changed in the [Peripheral Module Configuration] dialog box. For details on the [Peripheral Module Configuration] dialog box, refer to section 3.3, Simulating Peripheral Functions.

Table 2.6 Timer Control Registers Supported by the Simulator/Debugger

Names of Debugging Platforms	Timer	Supported Control Register	Status
SH-1	ITU0	TSTR	△
		TCR	△
		TIER	○
		TSR	○
		TCNT	○
		GRA	○
		GRB	○
SH-2/SH-2E/SH2-DSP (SH7065)/ SH2A-FPU	CMT0	CMSTR	○
		CMCSR	○
		CMCNT	○
		CMCOR	△
SH-3/SH3-DSP/SH3-DSP (Core) /SH-4/SH-4BSC/SH-4 (SH7750R) /SH4AL-DSP	TMU0	TCR	△
		TCNT	○
		TSTR	○
		TOCR	○
SH-4A	TMU0	TSTR0	○
		TCOR0	○
		TCNT0	○
		TCR0	△
		TSTR1	○
		TCOR3	○
		TCNT3	○
		TCR3	△

Table 2.6 Timer Control Registers Supported by the Simulator/Debugger (cont)

Names of Debugging Platforms	Timer	Supported Control Register	Status
SH2-DSP (Core)	FRT0	TIER	△
		FTCSR	△
		FRC	○
		OCRA	○
		OCRB	○
		TCR	△
		TOCR	△

Note: ○: Supported
△: Partly supported (bits for the function described in section 2.9.1, Supported Range)

2.9.3 Clocks

The simulator/debugger supports an internal clock that provides timing in access to memory, a peripheral function clock, and clocks for operating the timers.

The numbers of cycles of the internal clock required for access to memory correspond to the specifications for the memory map. Set the frequency ratio of the internal clock to the peripheral function clock in the [Set Peripheral Function Simulation] dialog box.

Use the timer control register to specify the division ratio to create the clock for operating the timers.

2.9.4 Using a Timer

To use a timer, the timer module must be registered in the [Set Peripheral Function Simulation] dialog box, which is opened at initiation of the simulator/debugger.

For details on the timer module registration, refer to section 3.3, Simulating Peripheral Functions.

2.9.5 Notes on Using a Timer

1. Even if the actual CPU can only clear a bit to 0, the simulator can write 1 to this bit.
2. During simulation, the SH-2DSP (core) accesses the 16-bit registers via a temporary register. However, during command access, the SH-2DSP (core) directly accesses those registers without using the temporary register.
3. The user can select whether or not to cause a break when a timer interrupt occurs. This can be set in the [Simulator System] dialog box or by the EXEC_STOP_SET command.

2.10 Control Registers

For the SH-3, SH-3E, SH3-DSP series, SH-4 series, and SH-4A series, the simulator/debugger supports the memory-mapped control registers that are used for exception processing, MMU control, and cache control. In addition, for the SH-4 series, the simulator/debugger also supports the control registers that are used for BSC and DMAC control. For the SH2A-FPU, the simulator/debugger supports the memory-mapped control registers that are used for cache control and register bank control. For the SH2-DSP (SH7612), the simulator/debugger only supports the CCR register that is used for cache control. Therefore, a user program using exception processing, MMU control, cache control, BSC control, and DMAC control can be simulated and debugged. For control registers related to timers, refer to section 2.9.2, Control Registers.

The control registers supported by the simulator/debugger are listed below.

MMU	PTEH:	Page table entry high register
	PTEL:	Page table entry low register
	TTB:	Translation table base register
	TEA:	TLB exception address register
	MMUCR:	MMU control register
	PASCR[*3*4]:	Physical address space control register
Exception processing	TRA:	TRAPA exception register
	EXPEVT:	Exception event register
	INTEVT:	Interrupt event register
INTC	IBCR[*5]:	Bank control register
	IBNR[*5]:	Bank number register
	USERIMASK[*3]:	User interrupt mask level setting register
INTC2[*3]	INT2PRI0:	Interrupt priority setting register 0
	INT2PRI1:	Interrupt priority setting register 1
	INT2A0:	Interrupt source register (mask state not affected)
	INT2A1:	Interrupt source register (mask state affected)
	INT2MSKR:	Interrupt mask register
	INT2MSKCR:	Interrupt mask clear register
	INT2B0:	Individual module interrupt source register
Cache	CCR:	Cache control register
	CCR1[*5]:	Cache control register 1
	CCR2[*1*5]:	Cache control register 2
	QACR0 and QACR1[*2*3]:	Queue address control registers 0 and 1
	RCCR[*5]:	ROM cache control register
	RCCR2[*5]:	ROM cache control register 2

	RCCR4[*5]:	ROM cache control register 4
BSC	BCR1 and BCR2[*2]:	Bus control registers 1 and 2
	WCR1 and WCR2[*2]:	Wait state control registers 1 and 2
	WCR3[*6]:	Wait state control register 3
	MCR[*6]:	Individual memory control register
	RTCSR[*6]:	Refresh timer control/status register
	RTCNT[*6]:	Refresh timer/counter
	RTCOR[*6]:	Refresh time constant register
	RFCR[*6]:	Refresh count register
DMAC	SAR0 to SAR3[*6]:	DMA source address registers 0 to 3
	DAR0 to DAR3[*6]:	DMA destination address registers 0 to 3
	DMATCR0 to DMATCR3[*6]:	DMA transfer count registers 0 to 3
	CHCR0 to CHCR3[*6]:	DMA channel control registers 0 to 3
	DMAOR[*6]:	DMA operation register
X/Y memory	XSA[*3]:	X memory transfer source address register
	YSA[*3]:	Y memory transfer source address register
	XDA[*3]:	X memory destination address register
	YDA[*3]:	Y memory destination address register
	XPR[*3]:	X bus protection control register
	YPR[*3]:	Y bus protection control register
	XER[*3]:	X bus exception control register
	YER[*3]:	Y bus exception control register
RAM	RAMACYC[*5]:	RAM access cycle setting register
L memory	LSA0 and LSA1[*4]:	L memory transfer source control register 0 and 1
	LDA0 and LDA1[*4]:	L memory transfer destination control register 0 and 1

Notes: 1. Only supported by the SH3-DSP series.
2. Only supported by SH-4 series.
3. Only supported by the SH-4A series.
4. Only supported by the SH4AL-DSP series.
5. Only supported by the SH2A-FPU series.
6. Only supported by the SH-4BSC series.
7. Only the CCR register is supported by the SH2-DSP (SH7612).

The simulator/debugger does not support the PCMCIA interface or the synchronous DRAM mode register.

To modify or display a control register value, use the [IO] window. For details, refer to section 17.6, Looking at I/O Memory, in the High-performance Embedded Workshop V.4.03 User's Manual.

In the SH-4/SH-4 (SH7750R), the simulator supports only a part of bits of the following registers.

Table 2.7 Control Registers Supported by SH-4/SH-4 (SH7750R) Simulator/Debugger

Register Name	Bit Name
BCR1	ENDIAN
BCR2	A6SZ-A0SZ
WCR1	A6IW-A0IW
WCR2	A6W-A0W

Note: Values of the registers that are not supported can be modified or referenced via the [IO] window, etc., but the simulator/debugger execution will not be affected.

2.11 Pipeline Reset Processing

The simulator/debugger that simulates the pipeline execution, resets the pipeline when:

- The program counter (PC) is modified after the instruction simulation stops and before it restarts.
- The Run command to which the execution start address has been specified is executed.
- Initialization is performed or the program is loaded.

When the pipeline is reset, data already fetched and decoded is discarded, and new data is fetched and decoded from the current PC. In addition, the number of executed instructions and the number of instruction execution cycles are zero-cleared.

2.12 Exception Processing

The simulator/debugger detects the generation of exceptions corresponding to TRAPA instructions, general illegal instructions, slot illegal instructions, and address errors. In addition, for the SH-3, SH-3E, SH3-DSP series, SH-4 series, and SH-4A series, the simulator/debugger simulates MMU-related exception processing (TLB miss, TLB protection exception, TLB invalid exception, and initial page write). For the SH-2E, SH-3E, SH-4 series, and SH-4 series, the simulator/debugger also simulates FPU exception processing. Accordingly, simulation can be performed even when an exception occurs.

The simulator/debugger simulates exception processing with the following procedures, depending on the [Execution Mode] setting in the [Simulator System] dialog box.

SH-1, SH-2, SH-2E, SH2A-FPU, and SH2-DSP Series:

- When [Continue] is selected (continuation mode):
  1. Detects an exception during instruction execution.
  2. Saves the PC and SR in the stack area.
  3. Reads the start address from the vector address corresponding to the vector number.
  4. Starts instruction execution from the start address. If the start address is 0, the simulator/debugger stops exception processing, shows that an exception processing error has occurred, and enters the command input wait state.
- When [Stop] is selected (stop mode):

  Executes steps 1 to 3 above, then stops.

SH-3, SH-3E, SH3-DSP Series and SH4AL-DSP:

- When [Continue] is selected (continuation mode):
  1. Detects an exception during instruction execution.
  2. Saves the PC and SR to the SPC and SSR, respectively.
  3. Sets the BL bit, RB bit, and MD bit in the SR to 1.
  4. Sets an exception code in control register EXPEVT. If necessary, appropriate values are set in other control registers.
  5. Sets the PC to the vector address corresponding to the exception source. (If an exception is detected when the BL bit in the SR is 1, reset vector address H'A0000000 is set in the PC regardless of the exception source.)
  6. Starts instruction execution from the address set in the PC.

- When [Stop] is selected (stop mode):
  Executes steps 1 to 5 above, then stops.

SH-4 Series and SH-4A:

- When [Continue] is selected (continuation mode):
  1. Detects an exception during instruction execution.
  2. Saves the PC and SR to the SPC and SSR, respectively.
  3. Sets the BL bit, RB bit, and MD bit in the SR to 1.
  4. Sets the FD (FPU disable) bit in the SR to 0 at reset.
  5. Sets an exception code in control register EXPEVT. If necessary, appropriate values are set in other control registers.
  6. Sets the PC to the vector address corresponding to the exception source. (If an exception is detected when the BL bit in the SR is 1, reset vector address H'A0000000 is set in the PC regardless of the exception source.)
  7. Starts instruction execution from the address set in the PC.
- When [Stop] is selected (stop mode):
  Executes steps 1 to 6 above, then stops.

2.13 Memory Management

Memory Map Specification: A memory map is used to calculate the number of memory access cycles during simulation. The following items can be specified:

- Memory type
- Start and end addresses of the memory area
- Number of memory access cycles
- Memory data bus width

The memory types that can be specified differ depending on the CPU. For details, refer to section 3.2, Modifying the Simulator/Debugger Settings. The user program can be executed in all areas except for the internal I/O area.

Memory Resource Specification: A memory resource must be specified to load and execute a user program. The following items can be specified:

- Start address
- End address
- Access type

The access type can be readable/writable, read-only, or write-only.

Since an error occurs if the user program attempts an illegal access (for example, trying to write to read-only memory), such an illegal access in the user program can be easily detected.

For details on memory resource setting, refer to section 3.2.2, Modifying the Memory Map and Memory Resource Settings.

2.14 Trace

The simulator/debugger writes the execution results of each instruction into the trace buffer. The conditions for trace information acquisition can be specified in the [Trace Acquisition] dialog box. Right-clicking on the [Trace] window displays the pop-up menu. Choose [Acquisition...] from the pop-up menu to display the [Trace Acquisition] dialog box. The acquired trace information is displayed in the [Trace] window. The trace information displayed in the [Trace] window differs according to the CPU.

The trace information can be searched. The search conditions can be specified in the [Trace Search] dialog box. Right-clicking on the [Trace] window displays the pop-up menu. Choose [Find...] from the pop-up menu to display the [Trace Search] dialog box.

For details, refer to section 3.5, Viewing Trace Information.

2.15 Standard I/O and File I/O Processing

The simulator/debugger enables the standard I/O and file I/O processing listed in table 2.8 to be executed by the user program. When the I/O processing is executed, the [Simulated I/O] window must be open. Table 2.8 shows the supported I/O functions.

Table 2.8 I/O Functions

No.	Function Code	Function Name	Description
1	H'21	GETC	Inputs one byte from the standard input
2	H'22	PUTC	Outputs one byte to the standard output
3	H'23	GETS	Inputs one line from the standard input
4	H'24	PUTS	Outputs one line to the standard output
5	H'25	FOPEN	Opens a file
6	H'06	FCLOSE	Closes a file
7	H'27	FGETC	Inputs one byte from a file
8	H'28	FPUTC	Outputs one byte to a file
9	H'29	FGETS	Inputs one line from a file
10	H'2A	FPUTS	Outputs one line to a file
11	H'0B	FEOF	Checks for end of the file
12	H'0C	FSEEK	Moves the file pointer
13	H'0D	FTELL	Returns the current position of the file pointer

For details on I/O functions, refer to section 3.10, Standard I/O and File I/O Processing.

2.16 Break Conditions

The simulator/debugger provides the following conditions for interrupting the simulation of a user program during execution.

- Break due to the satisfaction of a break command condition
- Break due to the detection of an error during execution of the user program
- Break due to a trace buffer overflow
- Break due to execution of the SLEEP instruction
- Break due to the [STOP] button

Break Due to Satisfaction of a Break Command Condition: There are six break commands as follows:

- BREAKPOINT: Break based on the address of the instruction executed
- BREAK_ACCESS: Break based on access to a memory range
- BREAK_CYCLE Break based on the number of execution cycles
- BREAK_DATA: Break based on the value of data written to memory
- BREAK_REGISTER: Break based on the value of data written to a register
- BREAK_SEQUENCE: Break based on a specified execution sequence

If [Stop] is specified as the action for when a break condition is satisfied, user program execution stops when the break condition is satisfied. For details, refer to section 3.4, Using the Simulator/Debugger Breakpoints.

When a break condition is satisfied and user program execution stops, the instruction at the breakpoint may or may not be executed before a break depending on the type of break, as listed in table 2.9.

Table 2.9 Processing When a Break Condition is Satisfied

Command	Instruction When a Break Condition is Satisfied
BREAKPOINT	Not executed
BREAK_ACCESS	Executed
BREAK_CYCLE	Executed
BREAK_DATA	Executed
BREAK_REGISTER	Executed
BREAK_SEQUENCE	Not executed

For BREAKPOINT and BREAK_SEQUENCE, if a breakpoint is specified at an address other than the beginning of an instruction, the break will not be detected.

When a break condition is satisfied during user program execution, a break condition satisfaction message is displayed in the [Output] window and execution stops.

Break Due to Error Detection during User Program Execution: The simulator/debugger detects simulation errors, that is, program errors that cannot be detected by the CPU exception generation functions. The [Simulator System] dialog box specifies whether to stop or continue the simulation when such an error occurs. Table 2.10 lists the error messages, error causes, and the action of the simulator/debugger in the continuation mode.

Table 2.10 Simulation Errors

Error Message	Error Cause	Processing in Continuation Mode
Memory Access Error (Address: H'nnnnnnnn)	Access to a memory area that has not been allocated	On memory write, nothing is written; on memory read, all bits are read as 1.
	Write to a memory area having the write-protected attribute	
	Read from a memory area having the read disable attribute	
	Access to an area where memory data do not exist	
	Access to a control register in an invalid size	
Illegal Operation	Zero division executed by the DIV1 instruction	Operates in the same way as the actual device operation.
	Writing zero by the SETRC instruction	
Illegal DSP Operation	Shift of more than 32 bits executed by the PSHA instruction	
	Shift of more than 16 bits executed by the PSHL instruction	
Invalid DSP Instruction Code	Invalid DSP instruction code	Always stops.
TLB Multiple Hit	Hit to multiple TLB entries at MMU address translation (only for the SH-3, SH-3E, and SH3-DSP series)	Undefined.

When a simulation error occurs in the stop mode, the simulator/debugger returns to the command input wait state after stopping instruction execution and displaying the error message. When a memory access error occurs, the address where the error occurred is also displayed. Table 2.11 lists the states of the program counter (PC) at a simulation error stop. The status register (SR) value does not change at a simulation error stop.

Table 2.11 Register States at Simulation Error Stop

Error Message	PC Value
Memory Access Error	• When an instruction is read: — SH2-DSP and SH3-DSP series The third instruction address before the instruction that caused the error. — SH-1, SH-2, SH-2E, SH-3, SH-3E, and SH-4 series The instruction address before the instruction that caused the error. The slot address if an error occurs when a branch destination is read. • When an instruction is executed: The instruction address following the instruction that caused the error.
Illegal Operation	The instruction address following the instruction that caused the error.
Illegal DSP Operation	The second instruction address following the instruction that caused the error.
Invalid DSP Instruction Code	The second instruction address following the instruction that caused the error.
TLB Multiple Hit	The address of the instruction that caused the error.

Use the following procedure when debugging programs that include instructions that generate simulation errors.

1. First execute the program in the stop mode and confirm that there are no errors except those in the intended locations.
2. After confirming the above, execute the program in the continuation mode.

Note: If an error occurs in the stop mode and simulation is continued after changing the simulator/debugger mode to the continuation mode, simulation may not be performed correctly. When restarting simulation, always restore the register contents (general, control, and system registers) and the memory contents to the state prior to the occurrence of the error.

Break Due to a Trace Buffer Overflow: After the [Break] mode is specified with [Trace Buffer Full Handling] in the [Trace Acquisition] dialog box, the simulator/debugger stops execution when the trace buffer becomes full. The following message is displayed in the [Output] window when execution is stopped.

```
Trace Buffer Full
```

Break Due to Execution of the SLEEP Instruction: When the SLEEP instruction is executed during instruction execution, the simulator/debugger stops execution. The following message is displayed in the [Output] window when execution is stopped.

```
Sleep
```

Note: When restarting execution, change the PC value to the instruction address at the restart location.

Break Due to the [STOP] Button: Users can forcibly terminate execution by clicking the [STOP] button during instruction execution. The following message is displayed in the [Output] window when execution is stopped.

```
Stop
```

Execution can be resumed with the GO or STEP command.

2.17 Floating-Point Data

Floating-point numbers can be used for the following real-number data, which makes floating-point data processing easier. The following data can be specified for floating-point data:

- Data when the break type is set to [Break Data] or [Break Register] in the [Select Break Type] dialog box
- Data in the [Memory] window
- Data in the [Fill Memory] dialog box
- Data in the [Search Memory] dialog box
- Input data in the [Register] dialog box

The floating-point data format conforms to the ANSI C standard.

In simulator/debugger, the rounding mode depends on the debugging platform as shown below:

Debugging Platform	[Round Mode]
SH-3, SH3-DSP series, SH-4 series, or SH4A-series	Round to Zero (RZ)
Others	Round to Nearest (RN)

If a denormalized number is specified for binary-to-decimal or decimal-to-binary conversion, it is converted to zero in RZ mode, and left as a denormalized number in RN mode. If an overflow occurs during decimal-to-binary conversion, the maximum floating-point value is returned in RZ mode, and the infinity is returned in RN mode.

2.18 Display of Function Call History

The simulator/debugger displays the function call history in the [Stack Trace] window when simulation stops, which enables program execution flow to be checked easily. Selecting a function name in the [Stack Trace] window displays the corresponding source program in the [Editor] window. This allows the function that has called the current function to also be checked.

The displayed function call history is updated in the following cases:

- When simulation stops due to the break conditions described in section 2.16, Break Conditions.
- When register values are modified while simulation stops due to the above break conditions.
- While single-step execution is performed.

For details, refer to section 17.15, Viewing the Function Call History in the High-performance Embedded Workshop V.4.03 User's Manual.

2.19 Performance Measurement

The simulator/debugger has the profiler function and performance analysis function for performance measurement of the user program.

2.19.1 Profiler

The profiler function displays the memory address and size allocated to functions and global variables, the number of function calls, and the profile data for the entire user program. The profile data to be displayed depends on the CPU.

Profile information is displayed in list, tree, and chart formats.

Profile information is useful in optimizing user programs by reducing the size and putting the most frequently called functions in-line.

When using the profile information saved in a file, it is possible to optimize user programs based on dynamic information using the optimizing linkage editor.

For details, refer to section 3.6, Viewing the Profile Information, and description of PROfile in section 4.2.4, Optimize Option in the Optimizing Linkage Editor User's Manual.

2.19.2 Performance Analysis

The performance analysis function displays the number of execution cycles and function calls for the specified function in the user program. Since performance data for only the specified function is acquired, faster simulation is possible. For details, refer to section 3.7, Analyzing Performance.

2.20 Pseudo-Interrupts

The simulator/debugger can generate pseudo-interrupts during simulation in the following two ways:

1. Pseudo-interrupts generated by satisfaction of break conditions

   A pseudo-interrupt can be generated using a break command to specify [Interrupt] as the action when a break condition is satisfied. For details, refer to section 3.4, Using the Simulator/Debugger Breakpoints.
2. Pseudo-interrupts generated from windows

   A pseudo-interrupt can be generated by clicking a button in the [Trigger] or [GUI I/O] window. For details, refer to section 3.9, Generating a Pseudo-Interrupt Manually.

If another pseudo-interrupt occurs between a pseudo-interrupt occurrence and its acceptance, only the interrupt that has a higher priority can be processed.

3. Break by pseudo-interrupts

   The user can select whether or not to cause a break when a pseudo-interrupt occurs. This can be set in the [Simulator System] dialog box or by the EXEC_STOP_SET command.

Note: Whether an interrupt is accepted is determined by the specifications of the CPU for the selected debugging platform. Note however that when H'11 is specified as the priority level of an interrupt, that interrupt is always accepted. The simulator/debugger does not simulate the operation of the interrupt controller.

2.21 Coverage

The simulator/debugger acquires instruction coverage information during instruction execution within the measurement range specified by the user.

This address range can either be a range entered directly by the user or through a source file, in which it covers several ranges dedicated for the functions.

The state of each instruction execution can be monitored through the instruction coverage information. In addition, this information can be used to determine which part of a program has not been executed.

The [Coverage] window displays the acquired instruction coverage information:

The instruction coverage information can be displayed in the [Editor] window by highlighting the column corresponding to the source line of the executed instruction.

The statistic of the instruction executed within a range, or a function is also displayed, in percentage. This gives the user a clear idea how much the program has been executed.

The instruction coverage information can be saved in or loaded from a file. Only a file in the .COV format can be loaded.

For details, refer to section 3.8, Acquiring Code Coverage.

Section 3 Debugging

This section describes the simulator/debugger operations and their related windows and dialog boxes.

For details on the functions common to the HEW listed below, refer to the HEW help information.

- Preparations for Debugging
- Viewing a Program
- Operating Memory
- Displaying Memory Contents as Waveforms
- Displaying Memory Contents as an Image
- Modifying the Memory Contents
- Viewing the I/O Memory
- Looking at Registers
- Executing Your Program
- Viewing the Current Status
- Synchronizing Multiple Debugging Platforms
- Debugging with the Command Line Interface
- Elf/Dwarf2 Support
- Looking at Labels

3.1 Creating the Workspace for Simulator/Debugger

To use the simulator/debugger, a workspace for the simulator/debugger must be created. This section only describes the procedures specific to the simulator/debugger. For details, refer to the HEW help.

3.1.1 Selecting a Debugging Platform

When you create a new workspace, the dialog box shown below appears. Specify the debugging platform (depending on the CPU type, endian, and simulator type) in step 7.

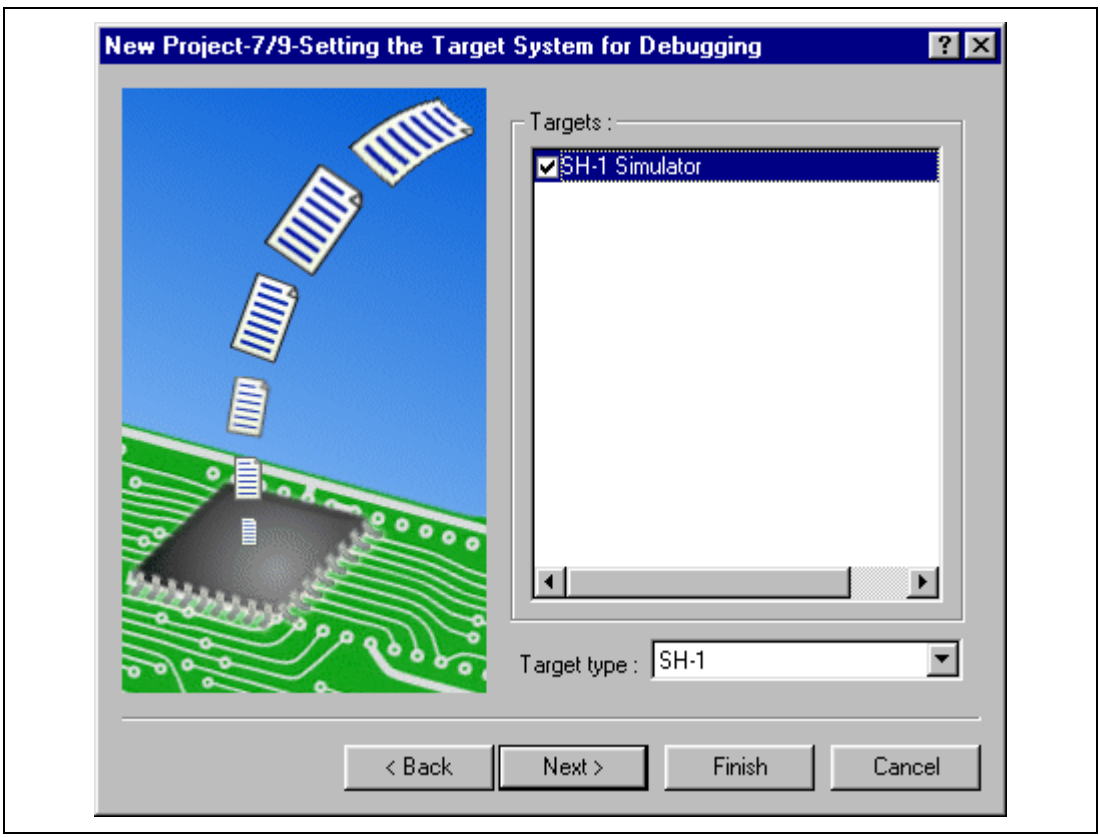


Figure 3.1 Debugger Target Setting Display (Step 7)

[Targets] Sets the debugger targets. Select (by checking) the debugger targets. No selection or a selection of more than one target is possible.

[Target type] Specifies the type of the targets displayed in [Targets].

Note: The endian type selected in step 2 will be applied to the compiler and assembler settings. This is not dependent on the endian type of the debugger target selected in step 7. In step 1, [SH-2A] not having the FPU or [SH2A-FPU] having the FPU can be selected. Even if you have selected [SH-2A] in step 1, you need to select the SH2A-FPU simulator in step 7 because the simulator/debugger only supports the SH2A-FPU.

3.1.2 Setting up a Workspace for the Simulator/Debugger

Set up the workspace for the simulator/debugger in step 8.

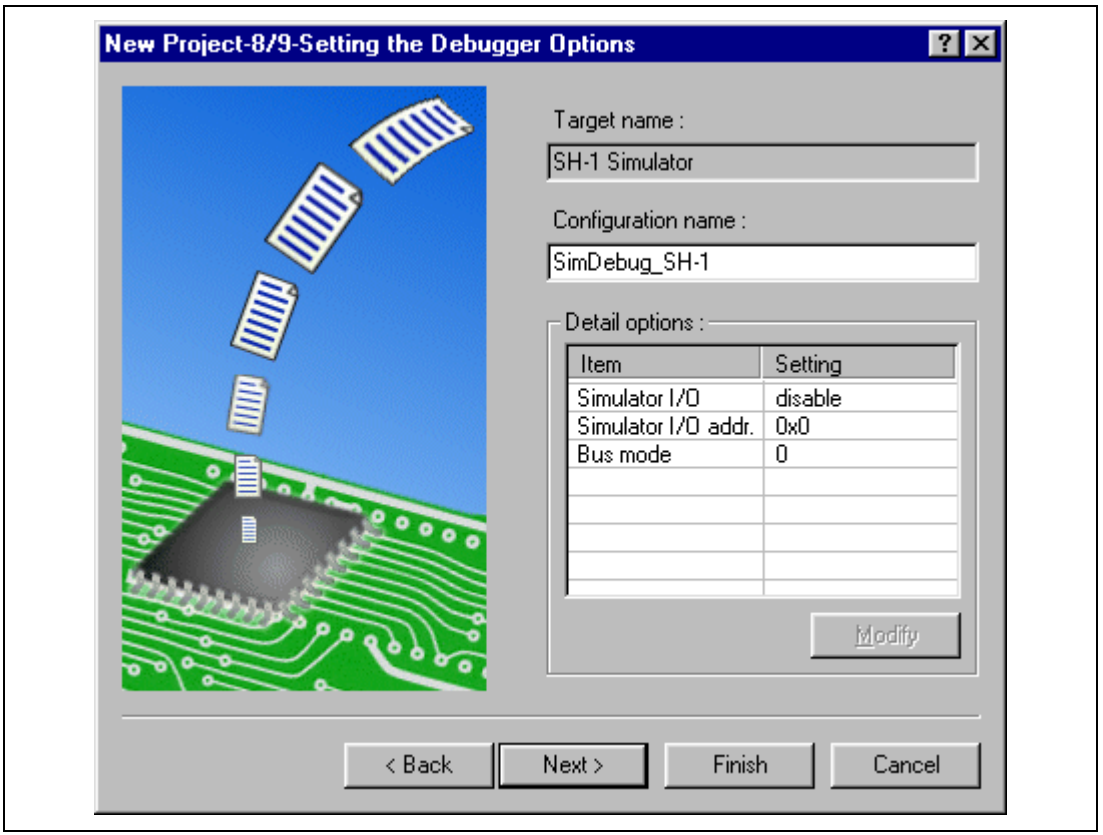


Figure 3.2 Debugger Option Setting Display (Step 8)

[Configuration name] By default, the HEW generates two configurations: [Release] and [Debug]. If a debugger target has been selected, a configuration for the selected target is also generated (an abbreviation including the target name). This configuration name can be changed in [Configuration name].

[Detail options] Sets the debugger target options. To modify an option, select [Item] and click [Modify]. If the selected item cannot be modified, [Modify] remains gray even when [Item] is selected.

[Simulator I/O]	Simulation for standard I/O or file I/O from the user program is enabled ([Enable]) or disabled ([Disable]).
[Simulator I/O addr.]	Address for the above simulated I/O.
[On-chip ROM mode]	Internal ROM capacity (SH2A-FPU only). Disable: Internal ROM is disabled Enable (128K byte): 128 Kbytes Enable (256K byte): 256 Kbytes Enable (512K byte): 512 Kbytes Enable (1M byte): 1 Mbytes Enable (2M byte): 2 Mbytes
[Bus mode]	Currently cannot be used by the simulator/debugger.

3.2 Modifying the Simulator/Debugger Settings

This section describes how to modify the simulator system, memory map, and memory resource settings after the simulator/debugger is started.

3.2.1 Modifying the Simulator System

The [System] tab in the [Simulator System] dialog box is used to modify the location to start the simulated I/O or execution mode.

Choose [Setup -> Simulator -> System...] or click the [Simulator System] toolbar button to open the [System] tab in this dialog box.

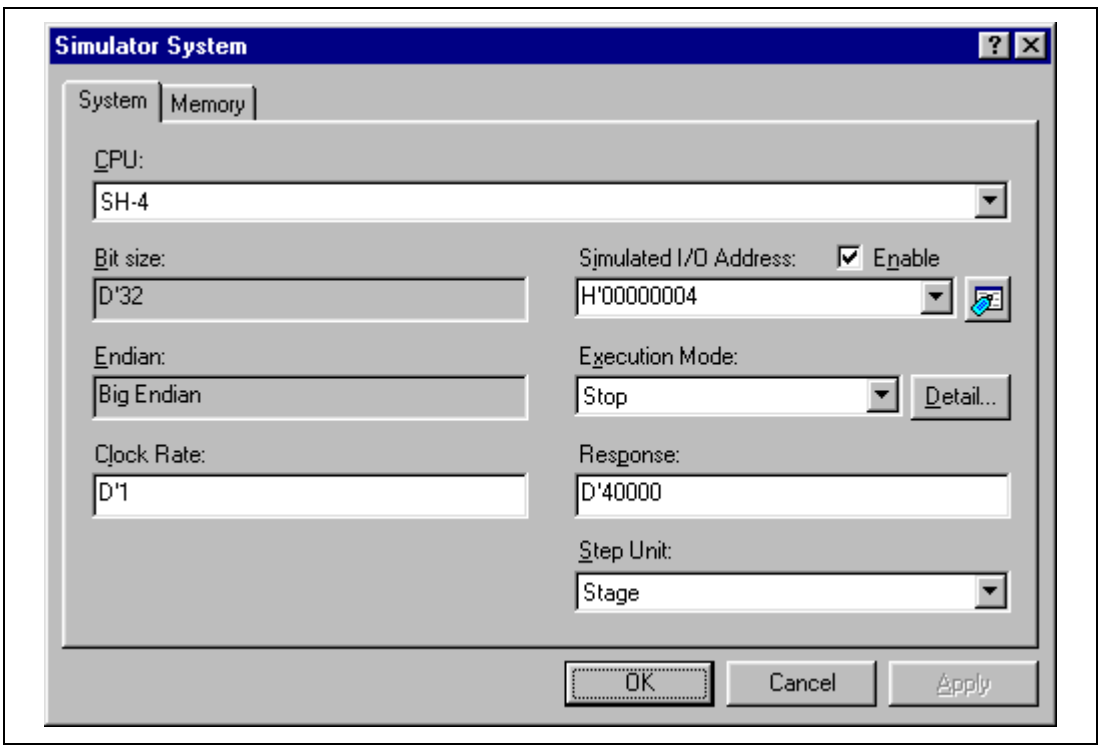


Figure 3.3 Simulator System Dialog Box (System Tab)

The following items can be specified in this dialog box:

[CPU] Current CPU. (The CPU must be specified in the [Debug Settings] dialog box.)
For the SH2-DSP (SH7410), select [Internal Mode] or [External Mode].
For SH2-DSP (SH7065), one of the followings can be selected:
[ROM Disable/Fast Mode] Internal ROM disabled/fast access mode
[ROM Disable/Slow Mode] Internal ROM disabled/slow access mode
[ROM Enable/Fast Mode] Internal ROM enabled/fast access mode
[ROM Enable/Slow Mode] Internal ROM enabled/slow access mode
For SH2-DSP (Core), either of the followings can be selected:
[ROM Disable] Internal ROM disabled mode
[ROM Enable] Internal ROM enabled mode

[Bit size] Address bus width fixed to 32 bits

[Endian] Currently selected endian

[Clock Rate] This can be specified only for SH-4 series.
Specify the internal clock ratio when the external clock is assumed 1. (H'1 to H'10)

[Simulated I/O Address] Start address of a simulated I/O that performs standard input/output or file input/output processing from the user program.
[Enable] Checking this box enables the simulated I/O.

[Response] Window refresh timing; that is, how many instructions should be executed between refresh operations (D'1 to D'2,147,483,647. The default is D'40000).

[Execution Mode] Whether the simulator/debugger stops or continues operation when a simulation error occurs. An interrupt is assumed as a simulation error. It is also possible to specify an action to take place when an interrupt occurs by clicking the [Detail…] button.
[Stop] Stops simulation.
[Continue] Continues simulation.

[Step Unit] This can be specified only for the SH-3, SH3-DSP series, and SH-4 series. Select the status of the instruction executed when STEP command is executed, and a PC break is satisfied.

[Stage]	Stops before instruction is executed. Pipeline operation is not affected.
[Instruction]	Stops after instruction is executed. Pipeline operation is affected, and as a result, the number of effective cycles becomes incorrect.

Clicking the [OK] or [Apply] button stores the modified settings. Clicking the [Cancel] button closes this dialog box without modifying the settings.

3.2.2 Modifying the Memory Map and Memory Resource Settings

The [Memory] tab in the [Simulator System] dialog box is used to set and modify the memory map and memory resource.

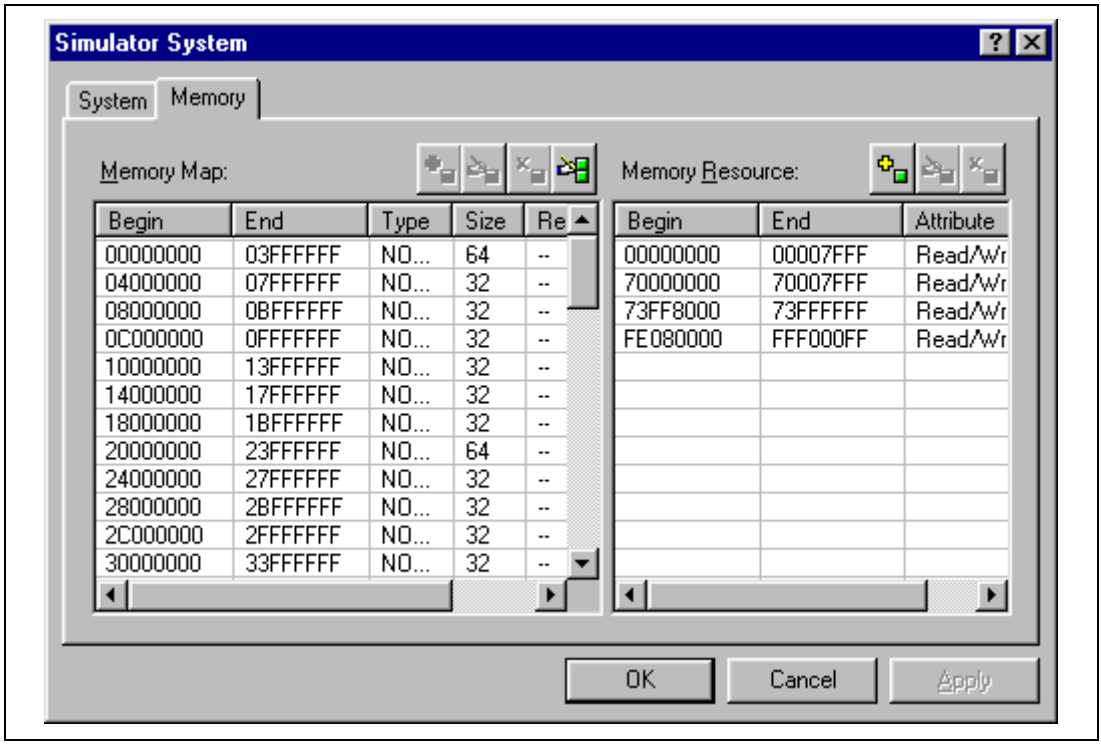


Figure 3.4 Simulator System Dialog Box (Memory Tab)

The following items can be specified in this dialog box:

[Memory Map] Displays the memory type, start and end addresses, data bus width, and the number of access cycles.

[Memory Resource] Displays the access type and start and end addresses of the current memory resource.

[Memory Map] can be added, modified, or deleted using the following buttons:

Adds [Memory Map] items. Clicking this button opens the [Set Memory Map] dialog box (figure 3.5), and memory map items can be added.

Modifies [Memory Map] items. Select an item to be modified in the list box and click this button. The [Set Memory Map] dialog box (figure 3.5) opens and memory map items can be modified.

Deletes [Memory Map] items. Select an item to be deleted in the list box and click this button.

[Memory Resource] can be added, modified, or deleted using the following buttons:

Adds [Memory Resource] items. Clicking this button opens the [Set Memory Resource] dialog box, and memory map items can be specified.

Modifies [Memory Resource] items. Select an item to be modified in the list box and click this button. The [Set Memory Resource] dialog box opens and memory map items can be modified.

Deletes [Memory Resource] items. Select an item to be deleted in the list box and click this button.

[Memory Resource] is the same setting information as that of [Memory Resource] of the [Debugger] sheet in the [SuperH RISC engine Standard Toolchain] dialog box. Modifications are reflected on both items.

When there is a linkage list file (.map) output by the optimizing linkage editor, the memory resource can be automatically allocated according to the memory map and linkage map information. For details, refer to section 13.1.9, Automatically Allocating the Memory Resource, in the High-performance Embedded Workshop V.4.03 User's Manual.

In the [Memory Map], the start address, end address, memory type, data bus width, read cycles, and write cycles are displayed in that order. The memory types are as follows:

- SH-1, SH-2, SH-2E, SH2A-FPU, SH-3, and SH-3E

  ROM (internal ROM), RAM (internal RAM), EXT (external memory), I/O (internal I/O)
- SH2-DSP (SH7410)/SH3-DSP

  XROM (internal XROM), YROM (internal YROM), XRAM (internal XRAM), YRAM (internal YRAM), EXT (external memory), I/O (internal I/O)
- SH2-DSP (SH7612)

  XRAM (internal XRAM), YRAM (internal YRAM), INTRAM (internal RAM), EXT (external memory), I/O (internal I/O)
- SH2-DSP (SH7065)

  XRAM (internal XRAM), YRAM (internal YRAM), INTROM (internal ROM), EXT (external memory), I/O (internal I/O)
- SH2-DSP (Core)

  XRAM (internal XRAM), YRAM (internal YRAM), INTROM (internal ROM), INTRAM (internal RAM), EXT (external memory), I/O (internal I/O)
- SH3-DSP (Core)

  XRAM (internal XRAM), YRAM (internal YRAM), URAM (user RAM), EXT (external memory), I/O (internal I/O)
- SH-4/SH-4 (SH7750R)

  NORMAL (normal memory), INTRAM (internal RAM), I/O (internal I/O)
- SH-4BSC

  NORMAL (normal memory), MPX (Multiplex), BCSRAM (byte-control SRAM), BSTROM (burst ROM and burst count), DRAM (DRAM), SDRAM (synchronous DRAM), INTRAM (internal RAM), I/O (internal I/O)
- SH-4A

  LRAM (internal RAM), URAM (user RAM), EXT (external memory), I/O (internal I/O)
- SH4AL-DSP

  XRAM (internal XRAM), YRAM (internal YRAM), URAM (user RAM), EXT (external memory), I/O (internal I/O)

Note: For the SH-4BSC, the following must be noted:

- The access cycle count is displayed as --.
- Memory map entries cannot be newly created or canceled. Therefore, only the [Modify] button can be used for [Memory Map].
- For the internal RAM and I/O, the memory map entries cannot be modified. To enable or disable the internal RAM, use the ORA bit of the CCR control register.
- The memory map contents depend on the BSC settings in addition to the settings in the [Memory Map Modify] dialog box. If the memory map contents cannot be determined due to BSC incorrect settings, this dialog box shows ?????? for memory types and ?? for the bus width.

[Memory Map] and [Memory Resource] can be reset to the default value by the button. Clicking the [OK] or [Apply] button stores the modified settings. Clicking the [Cancel] button closes this dialog box without modifying the settings.

3.2.3 Set Memory Map Dialog Box

The [Set Memory Map] dialog box specifies the memory map of the target CPU.

The contents displayed in this dialog box depend on the target CPU. The simulator/debugger uses the specified data to calculate the number of cycles for memory accesses.

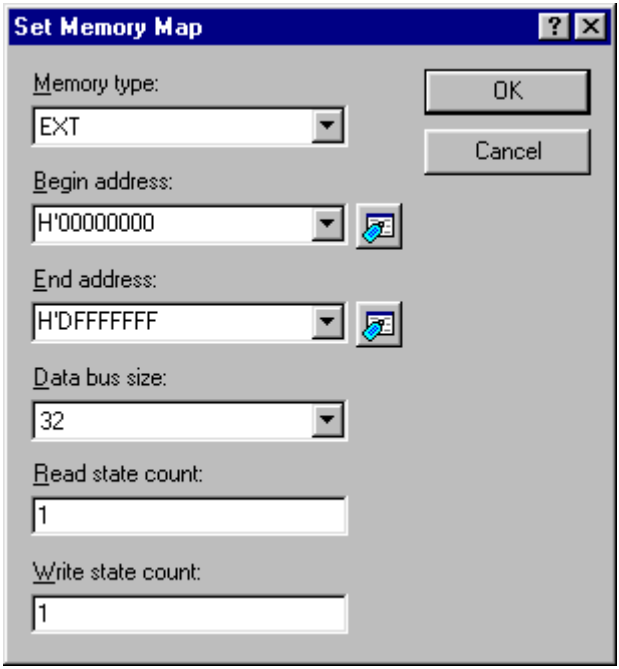


Figure 3.5 Set Memory Map Dialog Box

The following items are specified:

[Memory type]	Memory type
[Begin address]	Start address of the memory corresponding to the memory type
[End address]	End address of the memory corresponding to the memory type
[Data bus size]	Memory data bus width
[Read state count]	Number of cycles ("states") for read access to the specified type of memory
[Write state count]	Number of cycles ("states") for write access to the specified type of memory

For the SH-4 series, [Begin address] and [End address] cannot be modified. Specify [Memory type] and [Data bus size].

In addition, for the SH-4 series, clicking the [Set state...] button opens the [Set State] dialog box (section 3.2.4), and the number of wait-state cycles to be inserted in areas 0 to 7 can be specified. The specified values correspond to the values in the WCR1 and WCR2 control registers.

In terms of the memory resources of the SH-4 series and SH2A-FPU, note the following.

- [Memory type] cannot be modified.
- Unless the selected memory type is EXT, [Begin address] and [End address] are not modifiable.
- For the SH-4A series, [Write state count] is not modifiable, regardless of the selected type of memory.
- When an instruction-unit simulator is in use, settings for numbers of read cycles are invalid because the simulator/debugger handles one instruction per cycle.

Note: The memory map setting for the area allocated to a system memory resource cannot be deleted or modified. First delete the system memory resource allocation on the [Memory] tab of the [Simulator System] dialog box, then delete or modify the memory map setting.

Clicking the [OK] button stores the settings. Clicking the [Cancel] button closes this dialog box without modifying the settings.

3.2.4 Set State Dialog Box

The [Set State] dialog box specifies the wait-state cycles to be inserted in each area. This dialog box is provided only for the SH-4 series.

Note that only the normal memory is supported for the SH-4/SH-4 (SH7750R).

The [Set State] dialog box contents depend on the memory type allocated to the target area. The values set in this dialog box are also set in the WCR1 and WCR2 control registers.

Normal Memory, Burst ROM, and Byte-Control SRAM:

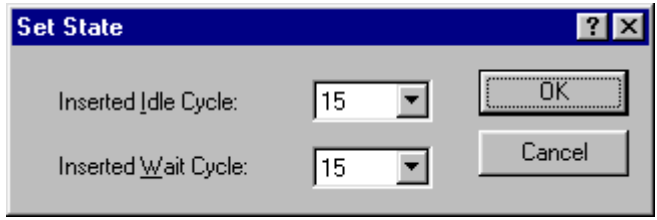


Figure 3.6 Set State Dialog Box (Normal Memory)

[Inserted Idle Cycle] Number of idle cycles to be inserted when the access type changes from read to write, or when the access area changes (corresponds to the AnIW in WCR1)

[Inserted Wait Cycle] Number of wait-state cycles to be inserted in all accesses (corresponds to the AnW in WCR2)

DRAM:

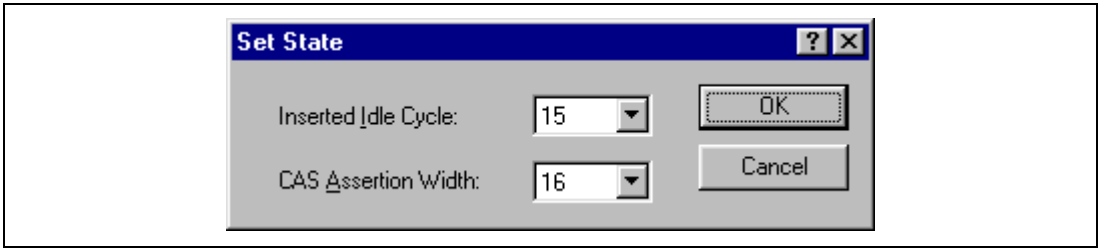


Figure 3.7 Set State Dialog Box (DRAM)

[Inserted Idle Cycle] Number of idle cycles to be inserted when the access type changes from read to write, or when the access area changes (corresponds to the AnIW in WCR1)

[CAS Assertion Width] $\overline{CAS}$ assertion width (corresponds to the AnW in WCR2)

SDRAM:

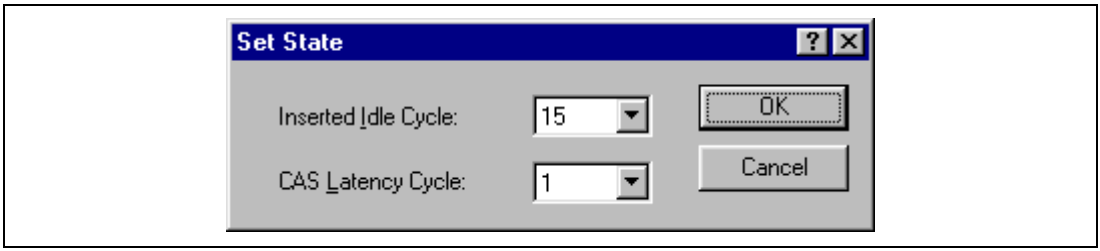


Figure 3.8 Set State Dialog Box (SDRAM)

[Inserted Idle Cycle] Number of idle cycles to be inserted when the access type changes from read to write, or when the access area changes (corresponds to the AnIW in WCR1)

[CAS Latency Cycle] Number of $\overline{CAS}$ latency cycles (corresponds to AnW in WCR2)

MPX:

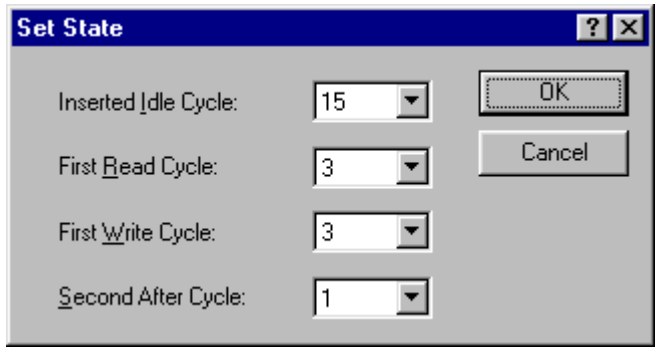


Figure 3.9 Set State Dialog Box (MPX)

[Inserted Idle Cycle]	Number of idle cycles to be inserted when the access type changes from read to write, or when the access area changes (corresponds to the AnIW in WCR1)
[First Read Cycle]*	Number of cycles to be inserted in the first cycle for the read access
[First Write Cycle]*	Number of cycles to be inserted in the first cycle for the write access
[Second After Cycle]*	Number of cycles to be inserted in the second and the following cycles for the burst transfer

Note: The items marked with * correspond to the AnW in WCR2.

3.2.5 Set Memory Resource Dialog Box

The [Set Memory Resource] dialog box sets and modifies memory resources.

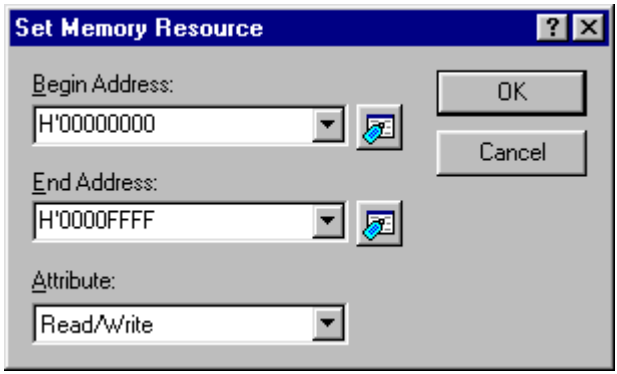


Figure 3.10 Set Memory Resource Dialog Box

The following items are specified:

[Begin Address] Start address of the memory area to be allocated

[End Address] End address of the memory area to be allocated

[Attribute] Access type

[Read]	Read only
[Write]	Write only
[Read/Write]	Readable/writable

Click the [OK] button after specifying the [Begin Address], [End Address], and [Attribute]. Clicking the [Cancel] button closes this dialog box without modifying the settings.

Notes: 1. If memory resources are set, memory in the host computer will be used. If the user allocates too much memory resources, operation of the host computer will be extremely slow.

2. There are the following notes on memory resources for the SH2A-FPU and SH-4A series:
   a. Memory resources can only be allocated on 64-kbyte boundaries. If memory resource is allocated across a 64-kbyte boundary, this memory resource will be aligned to 64-kbyte boundaries that include the specified memory range. Similarly, address ranges for attributes are also allocated on 64-kbyte boundaries. XRAM and YRAM are also allocated on 64-kbyte boundaries; thus the amount of memory actually used must be within the range defined in the hardware manual when specifying memory resource less than 64 kbytes.
   b. Do not clear the memory resources allocated as the I/O area at default. Otherwise, the operation of the MMU or cache memory will be incorrect.

3.3 Simulating Peripheral Functions

The simulator/debugger is able to simulate peripheral functions by using DLL modules. This section describes how to register the peripheral function simulation modules to enable the simulation of individual peripheral functions, and how to set their configurations.

3.3.1 Registering Peripheral Function Simulation Modules

Peripheral function simulation modules can be registered in the [Set Peripheral Function Simulation] dialog box, which is opened on initiation of the simulator/debugger.

Once a peripheral function simulation module has been registered in this dialog box, the simulated peripheral function provided by that simulation module becomes available. The registered settings cannot be modified after the simulator/debugger has fully started up. To change the peripheral function simulation modules that are in use, restart the simulator/debugger to bring up this dialog box.

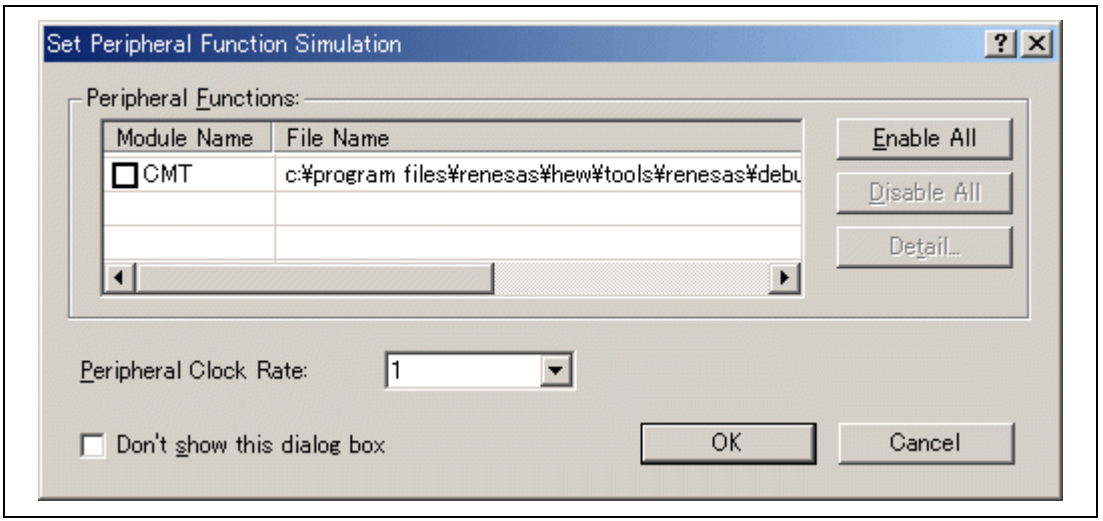


Figure 3.11 Set Peripheral Function Simulation Dialog Box

The following items are specified in this dialog box:

[Peripheral Functions] Shows information on the peripheral function simulation modules.
[Module Name] Names of peripheral functions to be simulated
[File Name] Names of files holding peripheral function simulation modules
Check the checkbox under [Module Name] to register the corresponding peripheral function simulation module and make it available.

[Enable All] Enables all peripheral functions.

[Disable All] Disables all peripheral functions.

[Detail…] Opens the [Peripheral Module Configuration] dialog box, allowing you to view information on the corresponding peripheral function, and change the address where it starts and the interrupt-source information.

[Peripheral Clock Rate] The ratio between the peripheral clock and the internal clock (the number of cycles of the internal clock corresponding to one cycle of the peripheral clock) is specified here. The clock rate setting can be selected as 1, 2, 3, 4, 6, 8, 12, 16, 24, or 32.

Clicking the [OK] button makes the settings effective. Clicking the [Cancel] button closes this dialog box without storing the settings.

If you do not wish this dialog box to be opened when the simulator/debugger is subsequently initiated, check [Don't show this dialog box].

3.3.2 Changing the Addresses of Peripheral Functions

The addresses of peripheral functions can be changed in the [Address] tab of the [Peripheral Module Configuration] dialog box. To open this dialog box, select a peripheral function in [Peripheral Functions] of the [Set Peripheral Function Simulation] dialog box and then press the [Detail…] button.

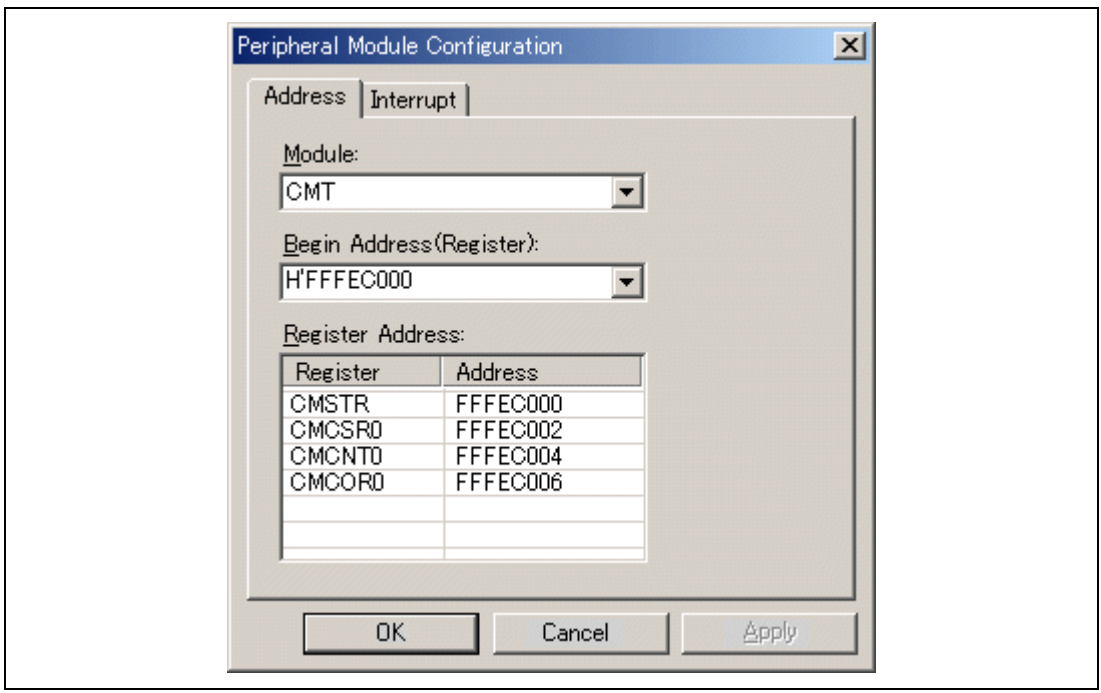


Figure 3.12 Peripheral Module Configuration Dialog Box (Address Tab)

The following items can be set or displayed in this dialog box:

[Module]	Name of the peripheral function supported by the selected peripheral function simulation module
[Start Address]	Start address of the peripheral function selected in [Module]
[Register Address]	Names and addresses of registers of the peripheral function selected in [Module]. It is not possible to change the register addresses.

Clicking the [OK] or [Set] button makes the settings effective. Clicking the [Cancel] button closes this dialog box without storing the settings.

3.3.3 Changing the Interrupt Source Information of Peripheral Functions

The interrupt source information of peripheral functions can be changed in the [Interrupt] tab of the [Peripheral Module Configuration] dialog box. To open this dialog box, select a peripheral function in [Peripheral Functions] of the [Set Peripheral Function Simulation] dialog box and then press the [Detail…] button.

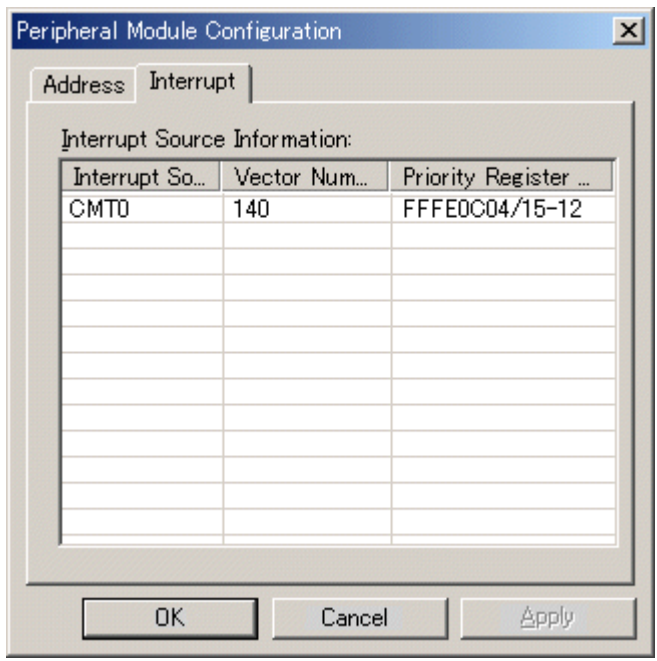


Figure 3.13 Peripheral Module Configuration Dialog Box (Interrupt Tab)

The following items can be displayed in this dialog box:

Interrupt Source:	Name of the interrupt source (or sources) supported by the peripheral function
INTEVT:	INTEVT value for SH-3, SH-4, and SH-4A series CPUs
INTEVT/INTEVT2:	INTEVT value and INTEVT2 value for SH3-DSP series CPUs
Vector Number:	Interrupt vector number for other CPUs
Priority Register Address/ Bit Field Position:	Address of the interrupt priority register and positions of bits in the register

To change the interrupt-source information, open the [Set Interrupt Source Information] dialog box by double-clicking on the line for the interrupt source to be changed.

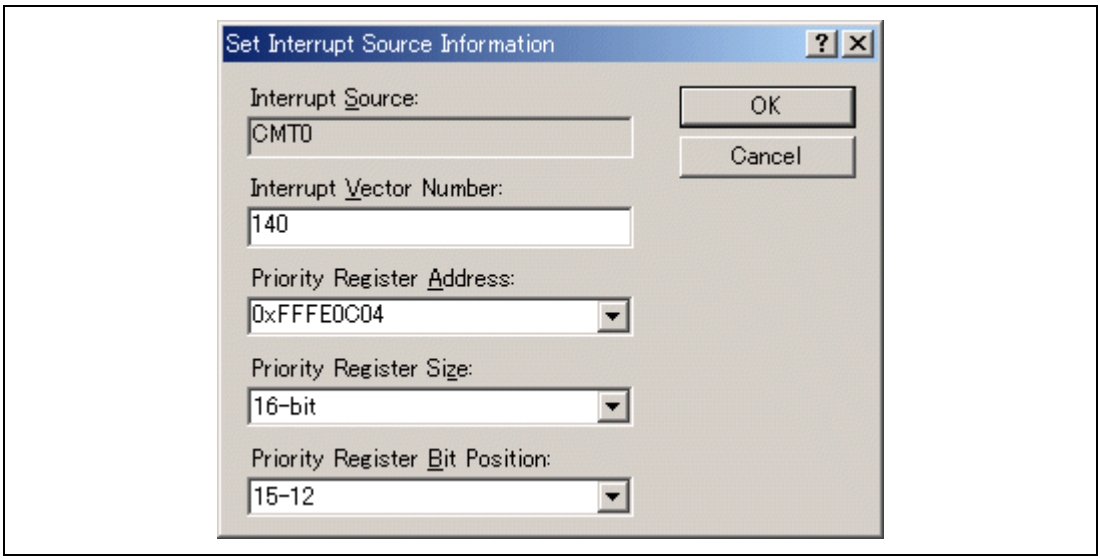


Figure 3.14 Set Interrupt Source Information Dialog Box

The following items can be set or displayed in this dialog box:

Interrupt Source:	Interrupt source name
INTEVT:	INTEVT value for SH-3, SH-4, SH-4A, and SH3-DSP series CPUs (when the prefix is omitted, values input are taken as hexadecimal, and the display is in hexadecimal notation)
INTEVT2:	INTEVT2 value for SH3-DSP series CPUs only (when the prefix is omitted, values input are taken as hexadecimal, and the display is in hexadecimal notation)
Interrupt Vector Number:	Interrupt vector number for other CPUs (when the prefix is omitted, values input are taken as decimal, and the display is in decimal notation)
Priority Register Address:	Address of the interrupt priority register
Priority Register Size:	Size of the interrupt priority register
Priority Register Bit Position:	Positions of bits in the interrupt priority register

Clicking the [OK] button makes the settings effective. Clicking the [Cancel] button closes this dialog box without storing the settings.

3.3.4 Changing the Address of the Bank Control Register (SH2A-FPU Only)

The following commands are used to display and change the addresses of the bank control register (IBCR) and the bank number register (IBNR) for products of the SH2A-FPU series.

REGISTER_ADDRESS_GET command: Displays the address of the bank control register

REGISTER_ADDRESS_SET command: Sets the address of the bank control register

For details on the commands, refer to the simulator help.

3.3.5 Allocating Memory Resources to the Interrupt Priority Register

The peripheral function simulation module does not allocate the interrupt priority register (IPR) to a location in memory. Allocate the memory resource for the interrupt priority register (IPR) through user operation. For details on the setting of memory resources, refer to section 3.2.2, Modifying the Memory Map and Memory Resource Settings.

3.3.6 Viewing the Names of Connected Peripheral Functions

After the simulator/debugger has been initiated, [Peripheral Modules] on the [Platform] sheet of the [Status] window shows the names of the peripheral functions that are connected.

3.4 Using the Simulator/Debugger Breakpoints

Sophisticated breakpoint functions are available in the simulator/debugger in addition to the HEW standard PC breakpoints. The user can specify break conditions and actions after a break condition is satisfied, and can display the breakpoints set.

3.4.1 Listing the Breakpoints

Choose [View -> Code -> Eventpoints] or click the [Eventpoints] toolbar button to open the [Event] window, which lists the breakpoints set.

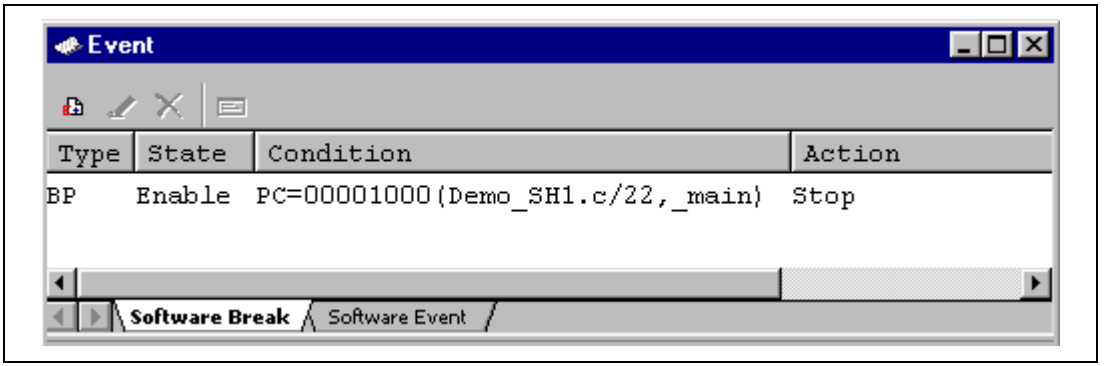


Figure 3.15 Event Window

The following items are displayed:

[Type] Break types
- [BP]: PC break
- [BA]: Access break
- [BD]: Data break
- [BR]: Register break (register name)
- [BS]: Sequential break
- [BCY]: Number-of cycles break

[State] Whether the breakpoint is enabled or disabled.
[Enable]: Valid
[Disable]: Invalid

[Condition] Condition that causes a break. The contents to be displayed depend on the type of the break. When the type of the break is BR, the register name is displayed, and when the type of the break is BCY, the number of cycles is displayed.
- BP: PC = Program counter (Corresponding file name, line, and symbol name)
- BA: Address = Address (Symbol name)
- BD: Address = Address (Symbol name)
- BR: Register = Register name
- BS: PC = Program counter (Corresponding file name, line, and symbol name)
- BCY: Cycle = Number of cycles (displayed in hexadecimal)

[Action] Operation of the simulator/debugger when a break condition is satisfied.
- [Stop]: Execution halts
- [File Input] (file name) [File state]: Memory data is read from file
- [File Output] (file name) [File state]: Memory data is written to file
- [Interrupt] (Interrupt type/priority): Interrupt processing. Only for the SH3-DSP, (Interrupt type 1, interrupt type 2/priority) is displayed.

Conditions specifying [Stop] for [Action] is displayed on the [Software Break] tab and the conditions specifying another action type is on the [Software Event] tab.

3.4.2 Setting a Breakpoint

Selecting [Add...] from the pop-up menu in the [Event] window opens the [Select Break Type] dialog box, which allows the user to set a breakpoint.

Two further dialog boxes can be opened from the [Select Break Type] dialog box: [Set xx Condition] for specifying a break condition and [Set xx Action] for specifying an action to take when the break condition is satisfied. To open the [Select Break Type] dialog box from the [Event] window when you wish to select [Stop] as [Action type] in the [Select Break Type] dialog box, select [Add...] from the pop-up menu on the [Software Break] tab; if you wish to select another action type, select [Add...] from the pop-up menu on the [Software Event] tab.

Selecting a Break Type:

Selecting [Add...] from the popup menu on the [Event] window opens the [Select Break Type] dialog box. Select a break type in the [Break type] combo box of this dialog box.

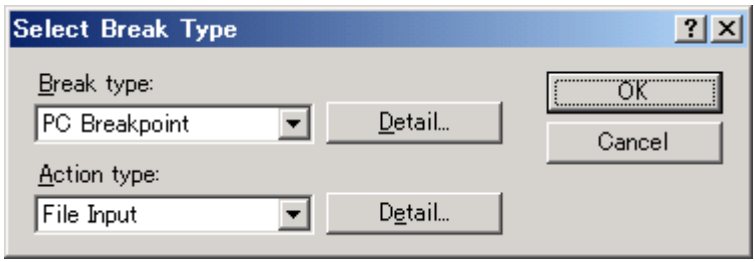


Figure 3.16 Select Break Type Dialog Box

The following options are available:

[Break type]

[PC Breakpoint]: Breakpoint set at an instruction
[Break Access]: Break on access to a memory range
[Break Data]: Break on detection of a memory value
[Break Register]: Break on detection of a register value
[Break Sequence]: Sequential breakpoints
[Break Cycle]: Break after the specified number of cycles

Setting Break Conditions:

Click on [Detail…] after selecting the break type in the [Select Break Type] dialog box. This opens a dialog box that allows you to set conditions for the selected break type.

- [PC Breakpoint]

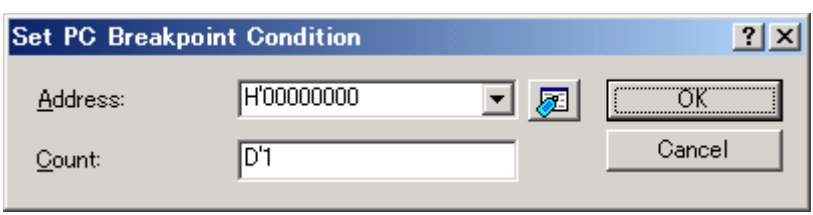


Figure 3.17 Set PC Breakpoint Condition Dialog Box

Up to 1024 PC-breakpoint conditions can be specified.

[Address]: Address of the instruction where a break will occur

[Count]: Number of times that the specified instruction is fetched (1 to 16,383; the default value is 1; if the prefix is omitted, values input are taken as decimal, and the display is in decimal notation).

- [Break Access]

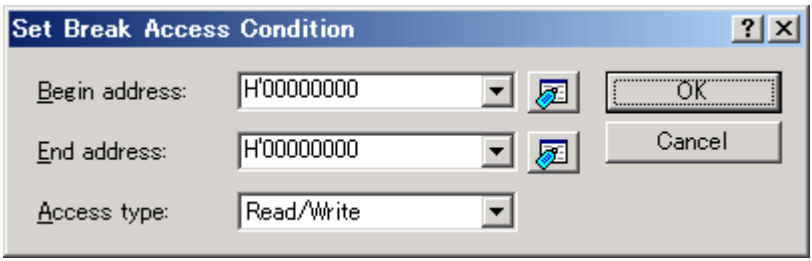


Figure 3.18 Set Access Break Condition Dialog Box

Up to 1024 access break conditions can be specified.

[Begin address]: First address of the range of memory for which access generates a break

[End address]: Last address of the range of memory for which access generates a break (if no data is input, the range corresponds to the first address alone)

[Access type]: Read, write, or read/write

- [Break Register]

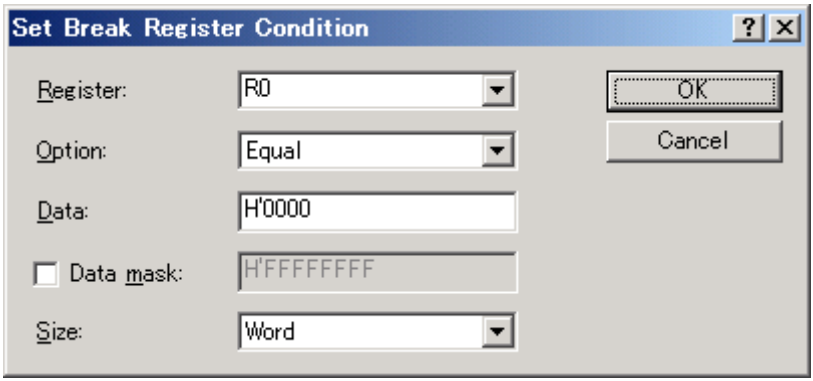


Figure 3.19 Set Register Break Condition Dialog Box

Up to 1024 register break conditions can be specified.

[Register]: Register name for which the break condition is specified
[Option]: Match or mismatch with the data
[Data]: Data value used in the break condition (if no data is input here, a break will occur whenever data is written to the register)
[Data mask]: Mask condition (specifying 0 for a bit masks the bit)
[Size]: Data size

- [Break Sequence]

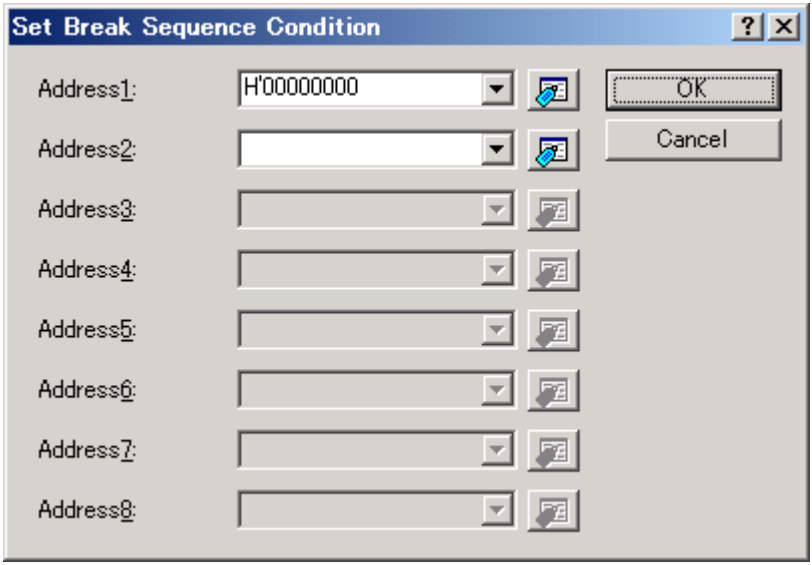


Figure 3.20 Set Break Sequence Condition Dialog Box

Only one sequential break condition can be specified.

[Address1] to [Address8]: Addresses that must be passed as conditions to generate the break (not all of the eight breakpoints have to be set).

- [Break Cycle]

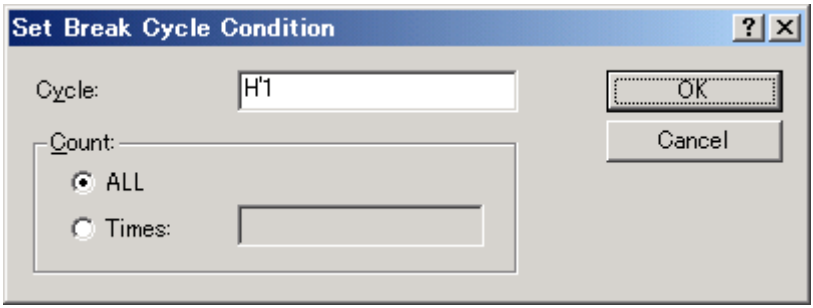


Figure 3.21 Set Number-of-Cycles Break Condition Dialog Box

Up to 1024 number-of-cycles break conditions can be specified.

[Cycle]: Number of cycles required to cause a break (H'1 to H'FFFFFFFF).
The condition will be satisfied by execution for the number of cycles in the [Cycle] setting × n.
However, the specified number of cycles may differ from the number of cycles on which the condition is satisfied.

[Count]: Number of times the break will occur

[ALL]: The break will occur whenever the condition is satisfied.

[Times]: The break will only occur up to the number of times specified as [Times] (1 to 65535; if the prefix is omitted, values input are taken as hexadecimal, and the display is in hexadecimal notation).

- [Break Data]

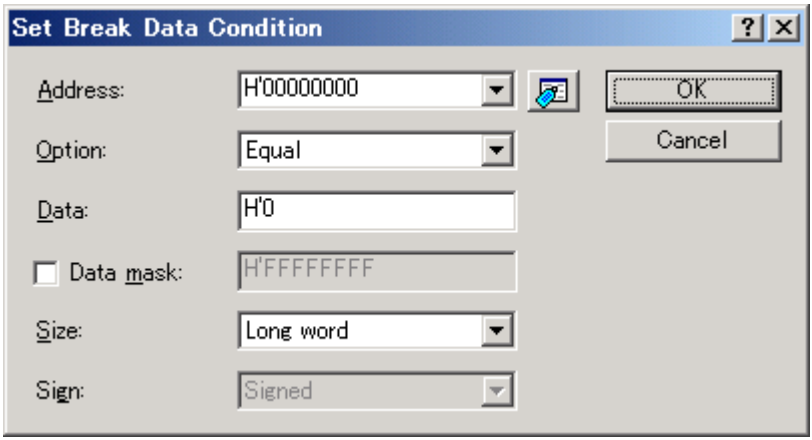


Figure 3.22 Set Data Break Condition Dialog Box

Data break conditions should be set as follows.

Up to 1024 data break conditions can be specified.

[Address]: Address in memory for which the break condition is specified

[Option]: How the data value is used to form the condition that must be satisfied for break generation

- [Equal]: The value written to memory matches [Data].
- [Not equal]: The value written to memory does not match [Data].
- [Inverse sign]*: The sign of the value written to memory is the inverse of that for the previous value.
- [Difference]*: The difference between the current and previous values written to memory exceeds [Data].

[Data]: Data value used in the break condition

[Data mask]: Mask condition (specifying 0 for a bit masks the bit). This option is only available when [Equal] or [Not equal] has been selected.

[Size]: Data size

[Sign]: Sign of the data.
This option is only available when [Difference] has been selected.

Note: Since [Inverse sign] and [Difference] require comparison of the data with the value previously written to memory, the break will never occur on the first test after a reset or break generation when either of these conditions has been selected.

- Point for Caution

For the SH3-DSP series, specify values within the range of addresses H'A5000000 to H'A501FFFF (X and Y memory virtual addresses, corresponding to physical addresses H'05000000 to H'0501FFFF) as [Begin address] and [End address] in [Break Access] and as [Address] in [Break Data] to set up a break condition that corresponds to access to X or Y memory by the MOVX or MOVY instruction.

Selecting an Action in Response to a Break:

If you click on [OK] after setting break conditions in the dialog boxes described on the preceding pages, the [Select Break Type] dialog box is opened again. Select an action type in the [Action type] combo box of this dialog box.

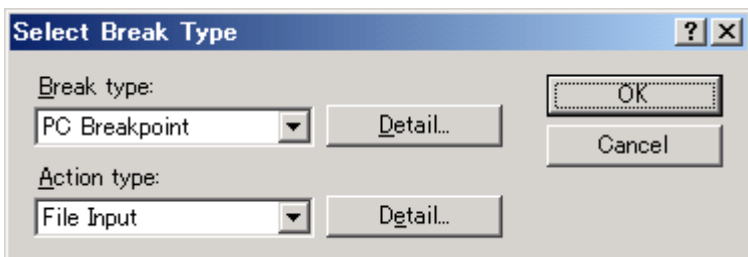


Figure 3.23 Select Break Type Dialog Box

The following options are available:

[Stop]:	Execution of the user program is stopped when the condition is satisfied.
[File Input]:	The contents of a specified file are read out and written to the specified memory when the condition is satisfied.
[File Output]:	The contents of the specified memory are read out and written to the specified file when the condition is satisfied.
[Interrupt]:	Interrupt processing proceeds when the condition is satisfied.

Setting Details of the Action:

Click on [Detail…] after selecting the action type in the [Select Break Type] dialog box. This opens a dialog box that allows you to set details of the selected action.

- [File Input]

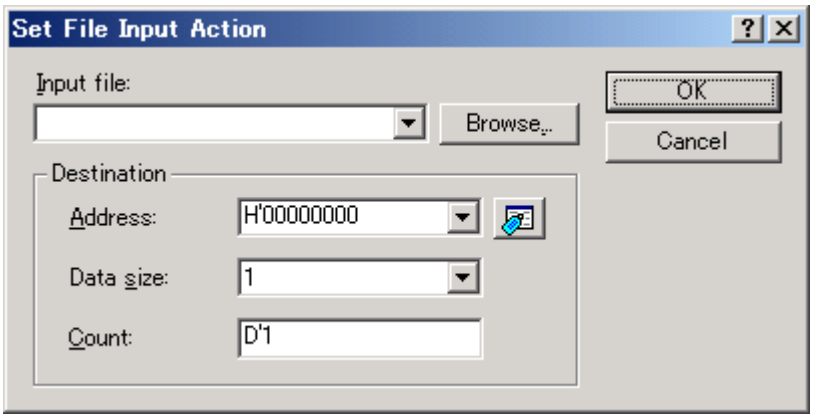


Figure 3.24 Set File Input Action Dialog Box

When the condition is satisfied, data are read out from the specified file and written to the specified location in memory.

[Input file]: File from which data are to be read out. When reading out by the simulator/debugger reaches the end of the file, reading out recommences from the beginning of the same file.

[Address]: Memory address to which data should be written.

[Data size]: Size of each data value in bytes (1/2/4/8).

[Count]: Number of values to be written (H'1 to H'FFFFFFFF; when the prefix is omitted, values input are taken as decimal, and the display is in decimal notation).

- [File Output]

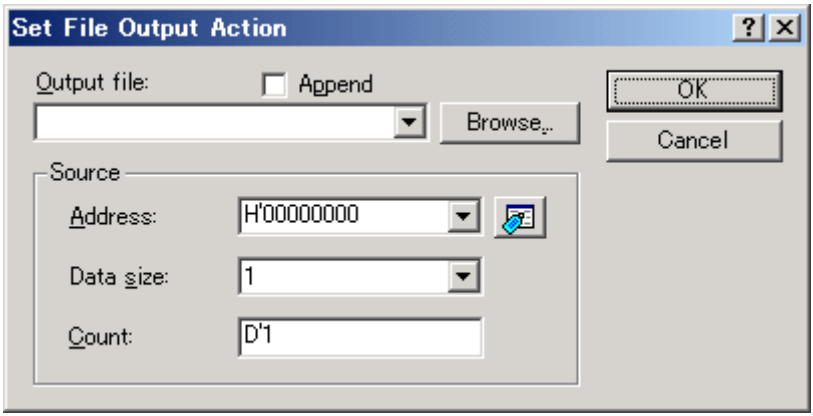


Figure 3.25 Set File Output Action Dialog Box

When the condition is satisfied, the contents at the specified location in memory are written to the specified file.

[Output file]: Data file to which data are written.
[Append]: Selects whether the data should be appended to the file if an existing file is specified as the output file.
[Address]: Memory address to read data from.
[Data size]: Size of each data value to be read (1/2/4/8).
[Count]: Number of values to be read (H'1 to H'FFFFFFFF; when the prefix is omitted, values input are taken as decimal, and the display is in decimal notation).

- [Interrupt]

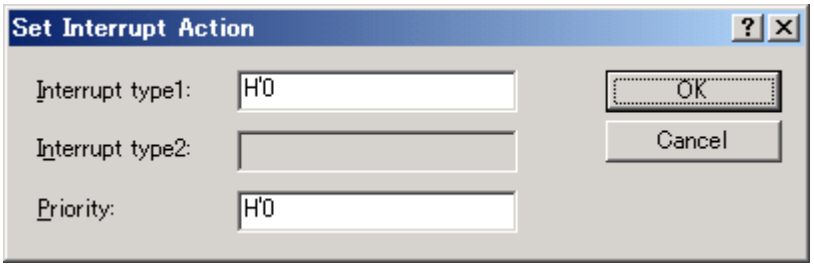


Figure 3.26 Set Interrupt Action Dialog Box

When the condition is satisfied, interrupt processing proceeds. For details, refer to section 2.20, Pseudo-Interrupts.

[Interrupt type 1]: Sets the following values for each CPU (when the prefix is omitted, values input are taken as hexadecimal, and the display is in hexadecimal notation)
- SH-1, SH-2, and SH2-DSP series
  Interrupt vector number
- SH2A-FPU
  Interrupt vector number
- SH-3, SH-4, and SH3-DSP series
  INTEVT (H'0 to H'FFF)
- SH-4A series
  INTEVT (H'0 to H'3FFF)

[Interrupt type 2]: Only selectable for the SH3-DSP series (when the prefix is omitted, values input are taken as hexadecimal, and the display is in hexadecimal notation): INTEVT2 (H'0 to H'FFF)

[Priority] Interrupt priority (H'0 to H'11; when the prefix is omitted, values input are taken as hexadecimal, and the display is in hexadecimal notation).
When H'10 is specified, the interrupt is always accepted regardless of the value of the I bit value in SR, but is masked by the BL bit in SR. When H'11 is specified, the interrupt is always accepted regardless of the I and BL bit values in SR.

- Point for Caution

When the same file is specified for multiple [File Input] actions, the simulator/debugger will read data from the file in the order of condition satisfaction. When the same file is specified for multiple [File Output] actions, the simulator/debugger will write data to the file in the order of condition satisfaction. However, when the same file is specified for [File Input] and [File Output], the only valid action is that for the first condition to be satisfied.

3.4.3 Modifying Breakpoints

Select a breakpoint to be modified, and choose [Edit...] from the pop-up menu to open the [Select Break Type] dialog box, which allows the user to modify the break conditions. The [Edit...] menu is only available when one breakpoint is selected.

3.4.4 Enabling a Breakpoint

Select a breakpoint and choose [Enable] from the pop-up menu to enable the selected breakpoint.

3.4.5 Disabling a Breakpoint

Select a breakpoint and choose [Disable] from the pop-up menu to disable the selected breakpoint. When a breakpoint is disabled, the breakpoint will remain in the list, but a break will not occur when the specified conditions have been satisfied.

3.4.6 Deleting a Breakpoint

Select a breakpoint and choose [Delete] from the pop-up menu to remove the selected breakpoint. To retain the breakpoint but not have it cause a break when its conditions are met, use the [Disable] option (see section 3.4.5, Disabling a Breakpoint).

3.4.7 Deleting All Breakpoints

Choose [Delete All] from the pop-up menu to remove all breakpoints.

3.4.8 Viewing the Source Line for a Breakpoint

Select a breakpoint and choose [Go to Source] from the pop-up menu to open the [Source] or [Disassembly] window at the address of the breakpoint. The [Go to Source] menu is only available when one breakpoint is selected.

3.4.9 Closing Input or Output File

Select a breakpoint and choose [Close File] from the pop-up menu to close the selected [File Input] or [File Output] data file and to reset the address to read the file.

3.4.10 Closing All Input and Output Files

Choose [Close All Files] from the pop-up menu to close all [File Input] and [File Output] data files and to reset the address for reading the file.

3.5 Viewing Trace Information

The simulator/debugger acquires the results of each instruction execution as trace information and displays it in the [Trace] window. The conditions for the trace information acquisition can be specified in the [Trace Acquisition] dialog box.

3.5.1 Opening the Trace Window

To open the [Trace] window, choose [View -> Code -> Trace] or click the [Trace] toolbar button .

3.5.2 Specifying Trace Acquisition Conditions

After the [Trace] window opens, specify the trace acquisition conditions in the [Trace Acquisition] dialog box. To open this dialog box, choose [Acquisition...] from the pop-up menu.

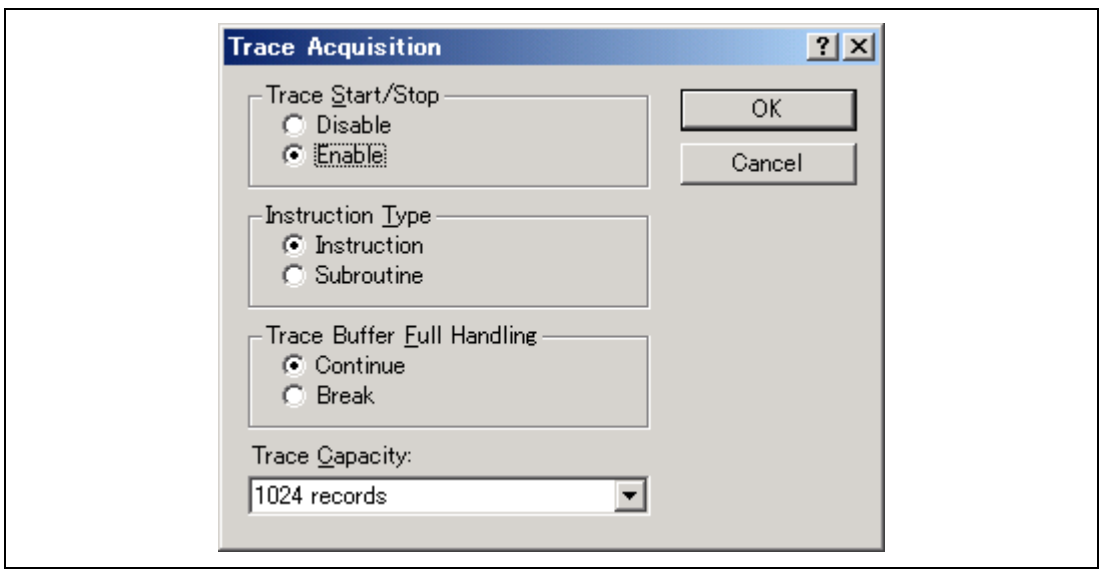


Figure 3.27 Trace Acquisition Dialog Box

This dialog box specifies the conditions for trace information acquisition.

[Trace Start/Stop]

[Disable]	Disables trace information acquisition.
[Enable]	Enables trace information acquisition.

[Instruction Type]

[Instruction]	Acquires trace information for all instructions.
[Subroutine]	Acquires trace information for the subroutine instructions only.

[Trace Buffer Full Handling]

[Continue]	Continues acquiring trace information even if the trace information acquisition buffer becomes full.
[Break]	Stops execution when the trace information acquisition buffer becomes full.

The trace buffer capacity can be selected from 1 Kbyte (1,024 records), 4 Kbytes (4,096 records), 16 Kbytes (16,384 records), 32 Kbytes (32,768 records), 64 Kbytes (65,536 records), 128 Kbytes (131,072 records), or 256 Kbytes (262,144 records) in [Trace Capacity].

Clicking the [OK] button stores the settings. Clicking the [Cancel] button closes this dialog box without modifying the settings.

3.5.3 Acquiring Trace Information

After trace acquisition is enabled, trace information is acquired during instruction execution. The acquired information will be displayed in the [Trace] window. The displayed information items depend on the target CPU as follows:

SH-1, SH-2, SH-2E, and SH2-DSP Series:

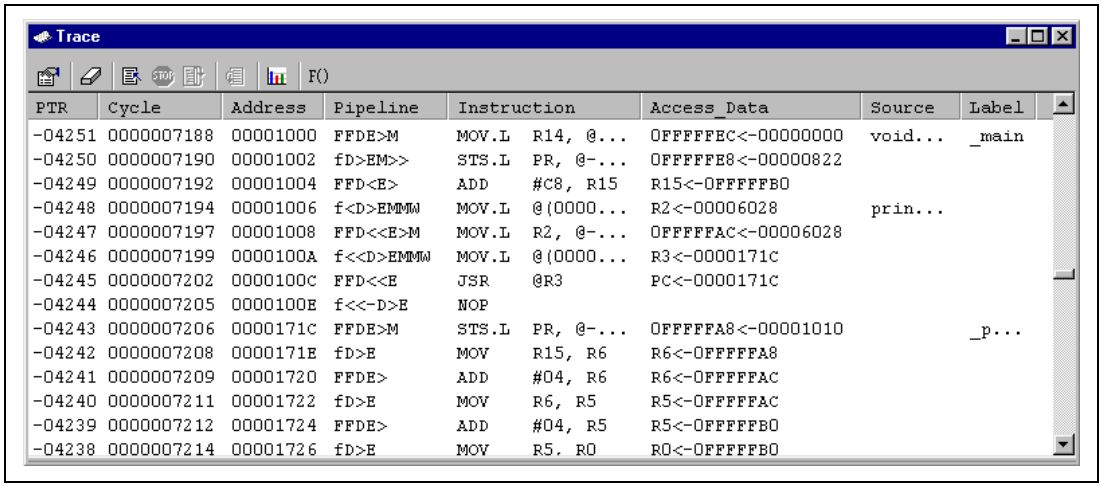


Figure 3.28 Trace Window (for SH-1, SH-2, SH-2E, and SH2-DSP Series)

This window displays the following trace information items:

[PTR] Pointer in the trace buffer (0 for the last executed instruction)

[Cycle] Total number of instruction execution cycles (cleared by pipeline reset)

[Address] Instruction address

[Pipeline] Pipeline execution status
Each symbol has the following meaning:
- F: Instruction fetch (with memory access)
- f: Instruction fetch (without memory access)
- D: Instruction decode
- E: Instruction execution
- M: Memory access
- W: Write back
- P: DSP

m: Multiplier execution
–: Stall inherent in the instruction
>: Split
<: Stall due to conflict

Refer to the software manual of each device for more information on pipeline operation.

[Instruction] Instruction mnemonic

[Access Data] Data access information (display format: destination <- accessed data)

[Source] C/C++ or assembly-language source programs

[Label] Labels

SH-3 and SH-3E Series:

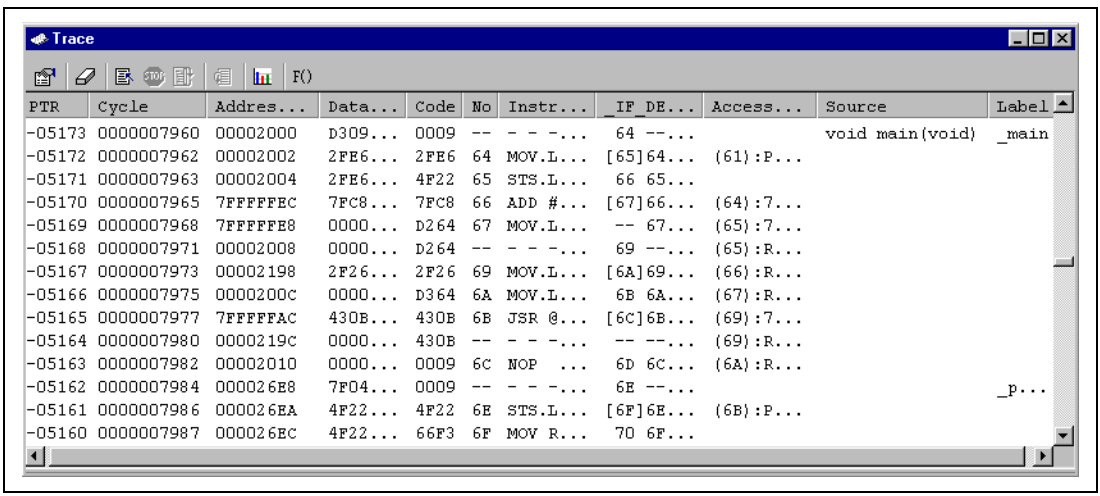


Figure 3.29 Trace Window (for SH-3 and SH-3E Series)

This window displays the following trace information items:

[PTR] Pointer in the trace buffer (0 for the last executed instruction)

[Cycle] Total number of instruction execution cycles (cleared by pipeline reset)

[Address Bus] Data on the address bus

[Data Bus] Data on the data bus

[Code]	Instruction code
[No]	Instruction number (corresponds to execution number in each stage)
[Instruction]	Instruction mnemonic
[IF]	Instruction number that was fetched (enclosed by [ ] when the instruction did not access memory)
[DE]	Instruction number that was decoded
[EX]	Instruction number that was executed
[MA]	Instruction number that accessed memory
[SW]	Instruction number that wrote back data
[Access Data]	Data access information (display format: destination <- accessed data)
[Source]	C/C++ or assembly-language source programs
[Label]	Labels

SH3-DSP Series:

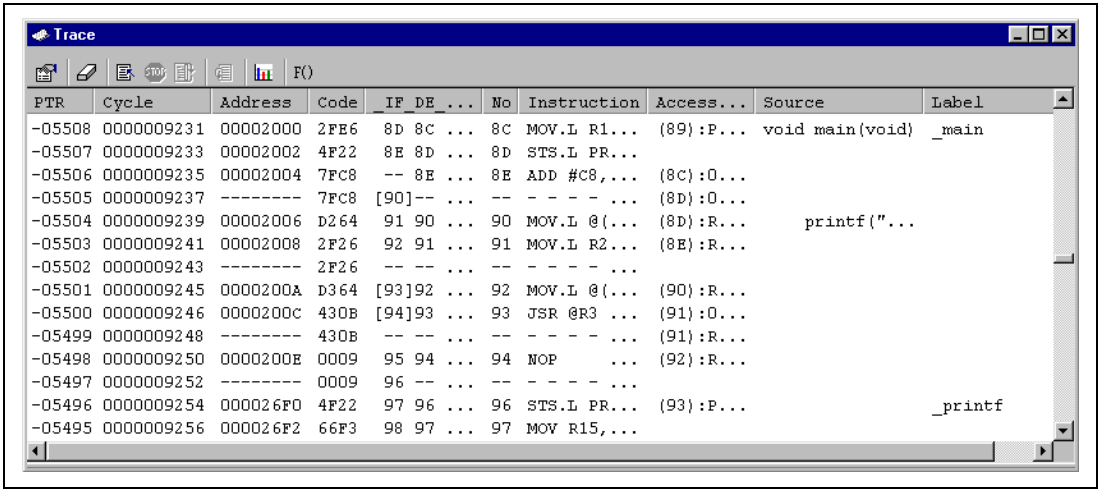


Figure 3.30 Trace Window (for SH3-DSP Series)

This window displays the following trace information items:

[PTR] Pointer in the trace buffer (0 for the last executed instruction)

[Cycle] Total number of instruction execution cycles (cleared by pipeline reset)

[Address] Program counter value

[Code] Instruction code

[IF] Instruction number that was fetched (enclosed by [ ] when the instruction did not access memory)

[DE] Instruction number that was decoded

[EX] Instruction number that was executed

[MA] Instruction number that accessed memory

[SW] Instruction number that wrote back data

[No] Instruction number (corresponds to execution number in each stage)

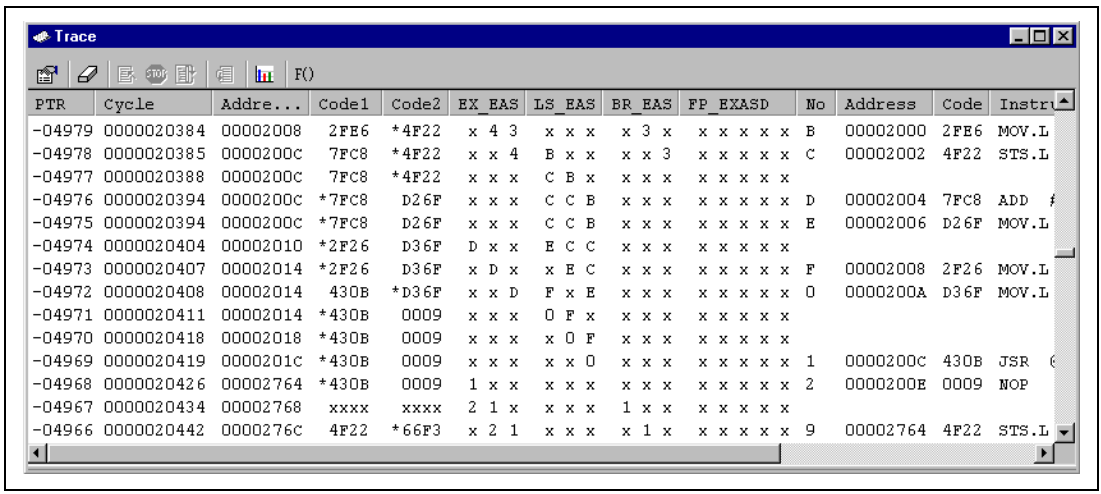
[Instruction] Instruction mnemonic

[Access Data] Data access information (display format: destination <- accessed data)

[Source] C/C++ or assembly-language source programs

[Label] Labels

SH-4 Series:



PTR	Cycle	Addre...	Code1	Code2	EX_EAS	LS_EAS	BR_EAS	FP_EXASD	No	Address	Code	Instru
-04979	0000020384	00002008	2FE6	*4F22	x 4 3	x x x	x 3 x	x x x x x	B	00002000	2FE6	MOV.L
-04978	0000020385	0000200C	7FC8	*4F22	x x 4	B x x	x x 3	x x x x x	C	00002002	4F22	STS.L
-04977	0000020388	0000200C	7FC8	*4F22	x x x	C B x	x x x	x x x x x				
-04976	0000020394	0000200C	*7FC8	D26F	x x x	C C B	x x x	x x x x x	D	00002004	7FC8	ADD #
-04975	0000020394	0000200C	*7FC8	D26F	x x x	C C B	x x x	x x x x x	E	00002006	D26F	MOV.L
-04974	0000020404	00002010	*2F26	D36F	D x x	E C C	x x x	x x x x x				
-04973	0000020407	00002014	*2F26	D36F	x D x	x E C	x x x	x x x x x	F	00002008	2F26	MOV.L
-04972	0000020408	00002014	430B	*D36F	x x D	F x E	x x x	x x x x x	0	0000200A	D36F	MOV.L
-04971	0000020411	00002014	*430B	0009	x x x	0 F x	x x x	x x x x x				
-04970	0000020418	00002018	*430B	0009	x x x	x 0 F	x x x	x x x x x				
-04969	0000020419	0000201C	*430B	0009	x x x	x x 0	x x x	x x x x x	1	0000200C	430B	JSR @
-04968	0000020426	00002764	*430B	0009	1 x x	x x x	x x x	x x x x x	2	0000200E	0009	NOP
-04967	0000020434	00002768	xxxx	xxxx	2 1 x	x x x	1 x x	x x x x x				
-04966	0000020442	0000276C	4F22	*66F3	x 2 1	x x x	x 1 x	x x x x x	9	00002764	4F22	STS.L

Figure 3.31 Trace Window (for SH-4 Series)

This window displays the following trace information items:

[PTR] Pointer in the trace buffer (0 for the last executed instruction)

[Cycle] Total number of instruction execution cycles (cleared by pipeline reset). The CPU internal clock cycles are counted as execution cycles. The rates of the external and internal clocks can be specified using the Clock Rate command.

[Address Bus] Program counter value

[Code1] Fetched code 1

[Code2] Fetched code 2
The code currently decoded is marked with *. If two codes are executed in parallel, the code fetched at the smaller address is marked with *.

[EX-EAS] Instruction number that was executed (in the E stage), accessed memory (in the A stage), or wrote back data (in the S stage) in the EX pipeline

[LS-EAS]	Instruction number that was executed, accessed memory, or wrote back data in the LS pipeline
[BR-EAS]	Instruction number that was executed, accessed memory, or wrote back data in the BR pipeline
[FP-EXASD]	Instruction number that was executed, accessed memory, or wrote back data in the FP pipeline (only for FSCA, FSRRA, FIPR, and FTRV instructions in the X stage, and for FDIV and FSQRT instructions in the D stage)
[No]	Instruction number (corresponds to execution number in each stage)
[Address]	Executed instruction address
[Code]	Executed instruction code
[Instruction]	Executed instruction mnemonic
[Access Data]	Data access information (display format: destination <- accessed data)
[Source]	C/C++ or assembly-language source programs
[Label]	Labels

SH2A-FPU and SH-4A Series:

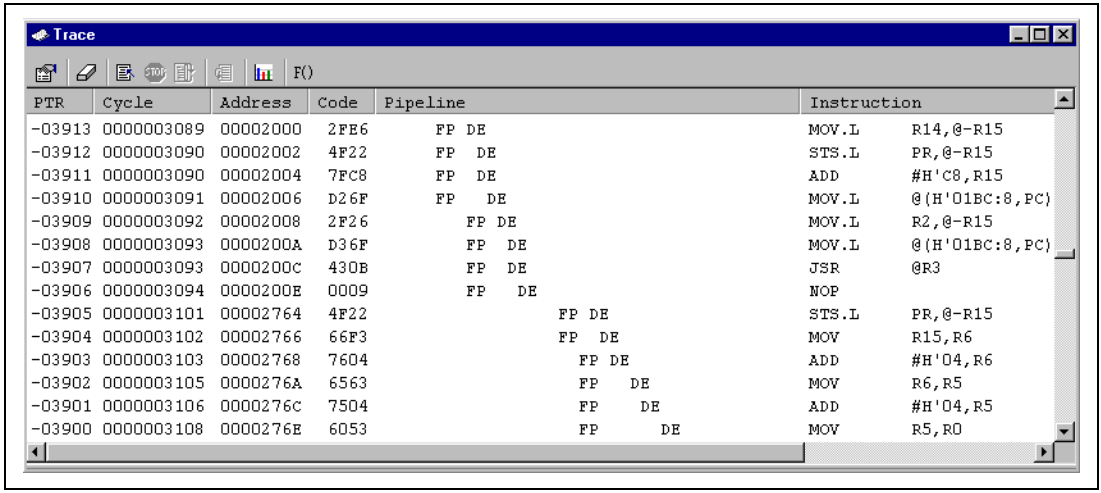


Figure 3.32 Trace Window (SH-4A Series)

This window displays the following trace information items:

[PTR] Pointer in the trace buffer (0 for the last executed instruction)

[Cycle] Total number of instruction execution cycles (cleared by pipeline reset)

[Address] Program counter value

[Code] Executed instruction code

[Pipeline] Pipeline execution status
Each symbol has the following meaning:
- F: Instruction fetch
- P: Instruction pre-decode (SH-4A series only)
- D: Instruction decode
- E: Instruction execution
- M: Memory access
- W: Write back

Refer to the software manual of each device for more information on pipeline operation. When a functional simulator is in use, there is no pipeline information. In this case, x will be displayed here. If the pipeline information exceeds the display space (the right edge of the [Pipeline] column), the display continues from the start (the left edge) of the column.

[Instruction]	Executed instruction mnemonic
[Access Data]	Data access information (display format: destination <- accessed data)
[Source]	C/C++ or assembly-language source program
[Label]	Labels

3.5.4 Searching for a Trace Record

Use the [Trace Search] dialog box to search for a trace record. To open this dialog box, choose [Find...] from the pop-up menu.

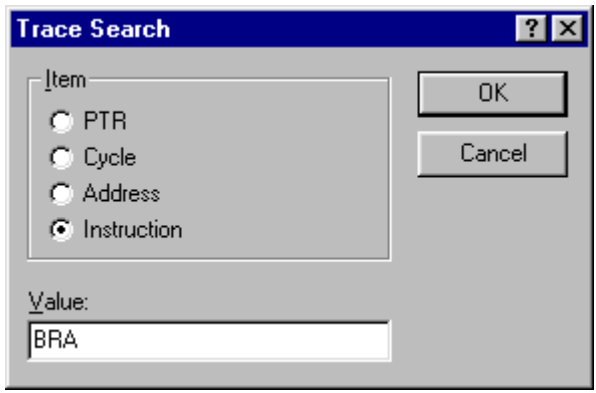


Figure 3.33 Trace Search Dialog Box

This dialog box specifies the conditions for searching trace information. Specify a search item in [Item] and search for the specified contents in [Value].

[PTR] Pointer in the trace buffer (0 for the last executed instruction, specify in the form of -nnn)

[Cycle] Total number of instruction execution cycles

[Address] Instruction address

[Instruction] Instruction mnemonic

Clicking the [OK] button stores the settings and starts searching. Clicking the [Cancel] button closes this dialog box without searching.

When a trace record that matches the search conditions is found, the line for the trace record will be displayed in blue. When no matching trace record is found, a message dialog box will appear.

If a search operation is successful, choosing [Find Next] from the pop-up menu will move to the next found item.

3.5.5 Clearing the Trace Information

Choose [Clear] form the pop-up menu to empty the trace buffer that stores the trace information. If more than one [Trace] window is open, all [Trace] windows will be cleared as they all access the same buffer.

3.5.6 Saving the Trace Information in a File

Choose [Save...] from the pop-up menu to open the [Save As] dialog box, which allows the user to save the contents of the trace buffer as a text file. A range can be specified based on [PTR]. Note that this file cannot be reloaded into the trace buffer.

3.5.7 Viewing the Source File

The [Editor] window corresponding to the selected trace record can be displayed in the following two ways:

- Select a trace record and choose [View Source] from the pop-up menu.
- Double-click a trace record

The [Editor] or [Disassembly] window opens and the selected line is marked with a cursor.

3.5.8 Trimming the Source

Choose [Trim Source] from he pop-up menu to remove the white space from the left side of the source.

When the white space is removed, a check mark is shown to the left of the [Trim Source] menu. To restore the white space, choose [Trim Source] while the check mark is shown.

3.5.9 Analyzing Statistical Information

Choose [Statistic] from the pop-up menu to open the [Trace Statistic] dialog box and analyze statistical information under the specified conditions.

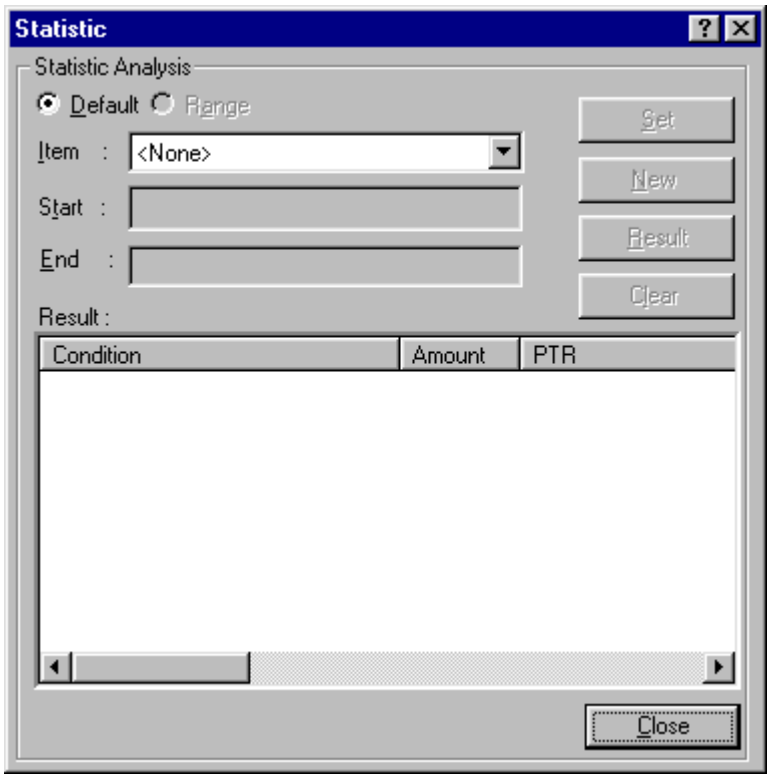


Figure 3.34 Trace Statistic Dialog Box

This dialog box allows the user to analyze statistical information concerning the trace information. The target of analysis is specified in [Item] and the input value or character string is specified by [Start] and [End].

When [Default] is selected, the input value or character string cannot be specified as a range. To specify a range, select [Range].

[Set] Adds a new condition to the current one

[New] Creates a new condition

[Result] Obtains the result of statistical information analysis

[Clear] Clears all condition and results of statistical information analysis

Clicking the [Close] button closes this dialog box.

3.6 Viewing the Profile Information

The profile function enables function-by-function measurement of the performance of the application program in execution. This makes it possible to identify parts of an application program that degrade its performance and the reasons for such degradation.

The HEW displays the results of measurement in three windows, according to the method and purpose of viewing the profile data.

3.6.1 Stack Information Files

The profile function allows the HEW to read the stack information files (extension: .SNI) which are output by the optimizing linkage editor (ver. 7.0 or later). Each of these files contains information related to the calling of static functions in the corresponding source file. Reading the stack information file makes it possible for the HEW to display information related to the calling of functions without executing the user application (i.e. before measuring the profile data). However, this feature is not available when [Setting->Only Executed Functions] is checked in the pop-up menu of the [Profile] window.

When the HEW does not read any stack information files, only the data on the functions executed during measurement will be displayed by the profile function.

To make the linkage editor create a stack information file, choose [Build -> SuperH RISC engine Standard Toolchain...], and select [Other] from the [Category] list box and check the [Stack information output] box in the [Link/Library] sheet of the [Standard Toolchain] dialog box.

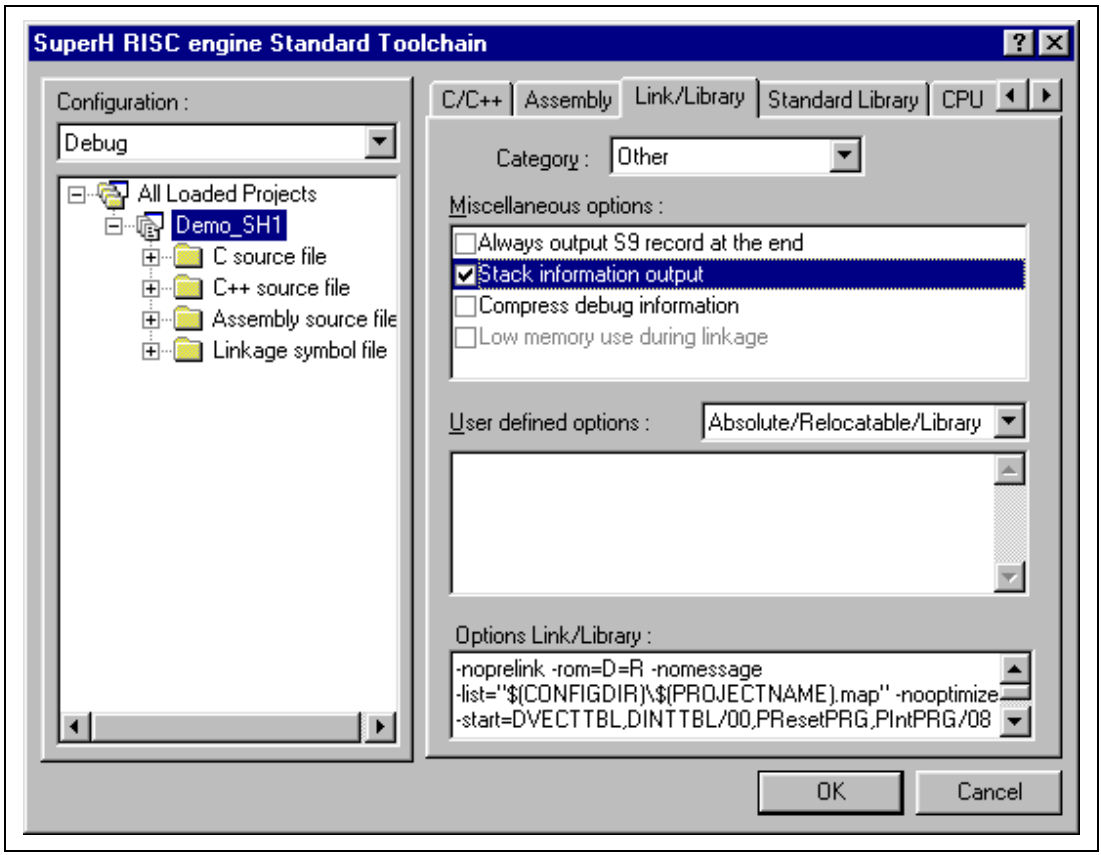


Figure 3.35 Standard Toolchain Dialog Box (1)

3.6.2 Profile Information Files

To create a profile information file, measure a profile data of the application program then choose the [Output Profile Information Files…] menu option from the pop-up menu of the [Profile] window and specify the file name.

This file contains information on the number of times functions are called and global variables are accessed. The optimizing linkage editor (ver. 7.0 or later) is capable of reading the profile information file and optimizing the allocation of functions and variables in correspondence with the state of the actual operation of the program.

To input the profiler information file to the linkage editor, choose [Optimize] from the [Category] list box and check the [Include profile] box in the [Link/Library] sheet of the [Standard Toolchain] dialog box, and specify the name of the profile information file.

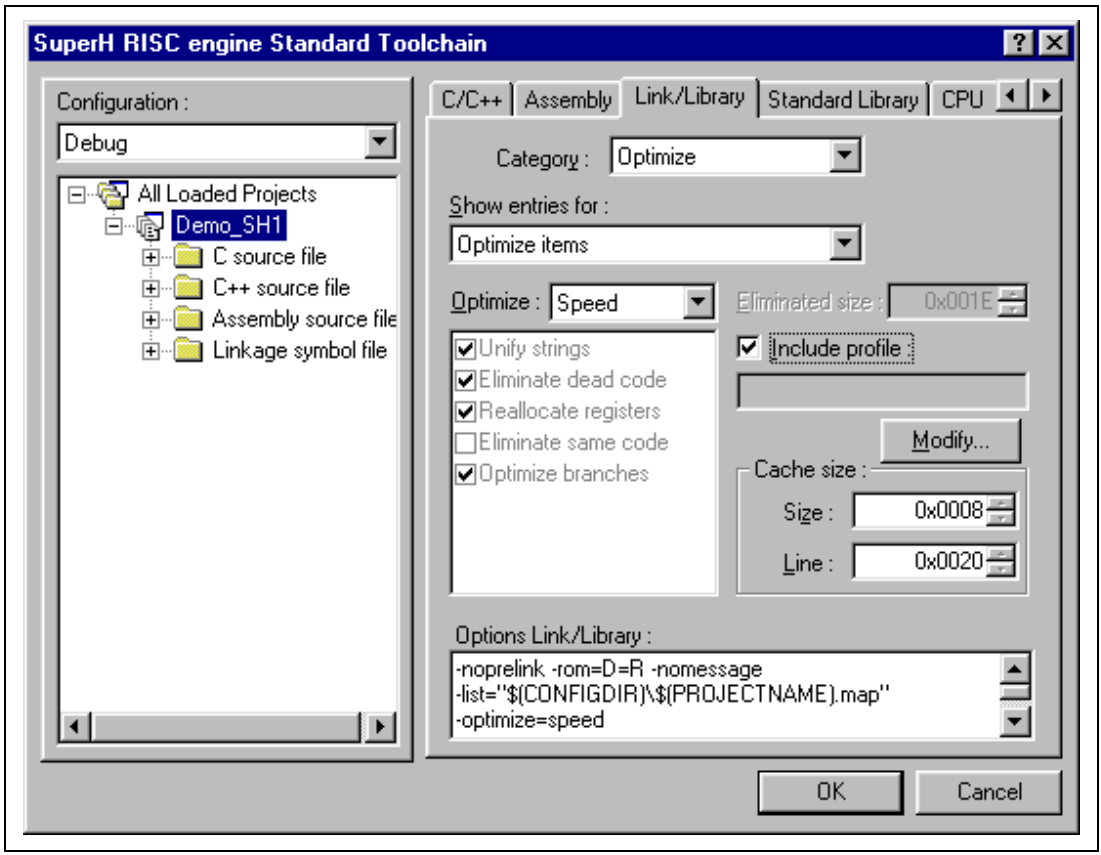


Figure 3.36 Standard Toolchain Dialog Box (2)

To enable the settings in the [Include profile] box, specify the [Optimize] list box as some setting other than [None].

3.6.3 Loading Stack Information Files

You can select whether or not to read the stack information file in a message box for confirmation that is displayed when a load module is loaded. Clicking the [OK] button of the message box loads the stack information file. The message box for confirmation will be displayed when:

- There are stack information files (extension: .SNI).
- The [Load Stack Information Files (SNI files)] check box is checked in the [Confirmation] tab of the [Options] dialog box (figure 3.37) that can be opened by choosing [Setup -> Options…] from the main menu.

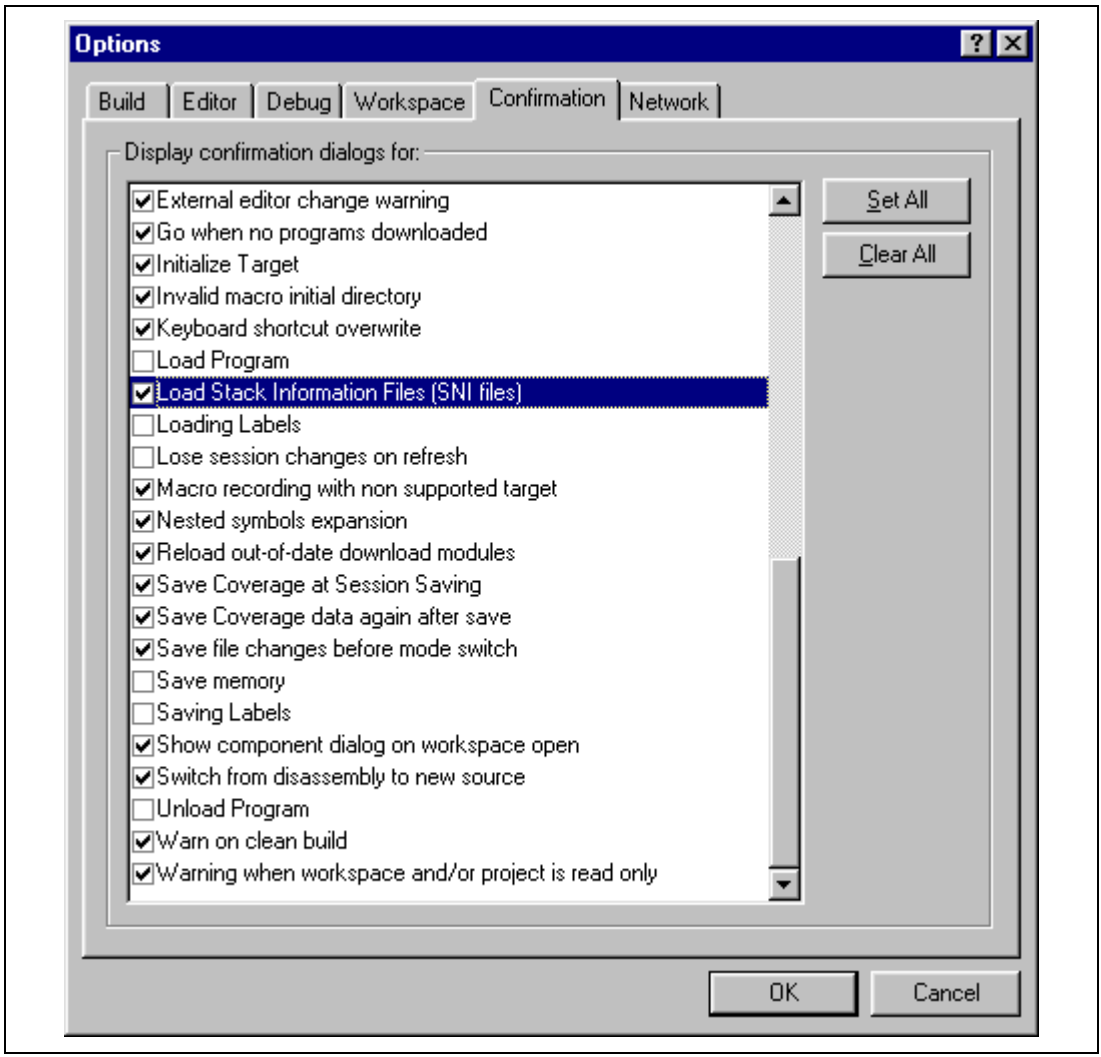


Figure 3.37 Options Dialog Box

3.6.4 Enabling the Profile

Choose [View->Performance->Profile] to open the [Profile] window.

Choose [Enable Profiler] from the pop-up menu of the [Profile] window. The item on the menu will be checked.

3.6.5 Specifying Measurement Mode

You can specify whether to trace functions calls while profile data is acquired. When function calls are traced, the relations of function calls during user program execution are displayed as a tree diagram. When not traced, the relations of function calls cannot be displayed, but the time for acquiring profile data can be reduced.

To stop tracing function calls, choose [Disable Tree (Not traces function call)] from the pop-up menu in the [Profile] window (a check mark is shown to the left of the menu item).

When acquiring profile data of the program in which functions are called in a special way, such as task switching in the OS, stop tracing function calls.

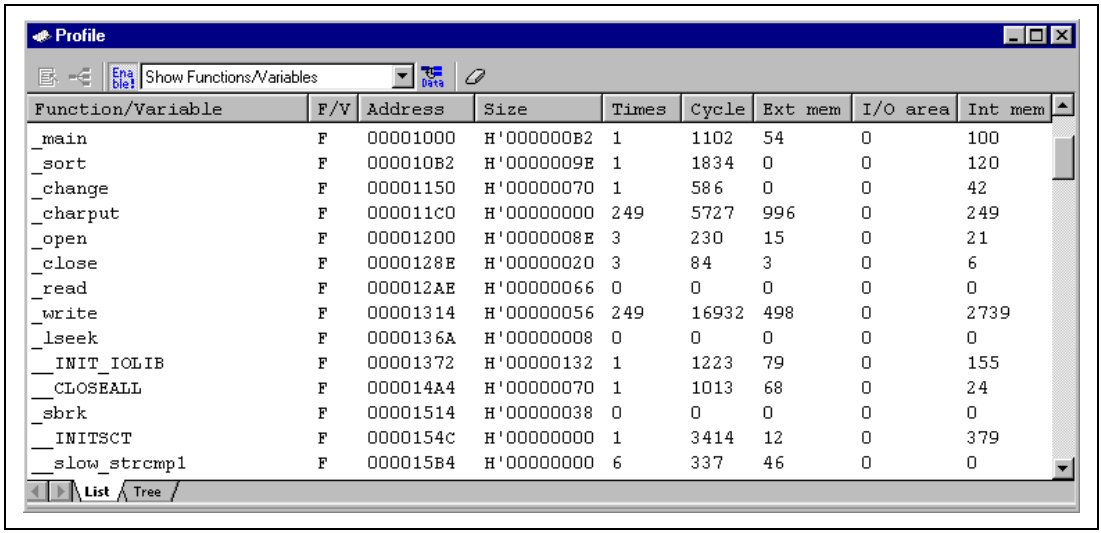
3.6.6 Executing the Program and Checking the Results

After the user program has been executed and execution has been halted, the results of measurement are displayed in the [Profile] window.

The [Profile] window has two sheets; a [List] sheet and a [Tree] sheet.

3.6.7 List Sheet

This sheet lists functions and global variables and displays the profile data for each function and variable.



Function/Variable	F/V	Address	Size	Times	Cycle	Ext mem	I/O area	Int mem
_main	F	00001000	H'000000B2	1	1102	54	0	100
_sort	F	000010B2	H'0000009E	1	1834	0	0	120
_change	F	00001150	H'00000070	1	586	0	0	42
_charput	F	000011C0	H'00000000	249	5727	996	0	249
_open	F	00001200	H'0000008E	3	230	15	0	21
_close	F	0000128E	H'00000020	3	84	3	0	6
_read	F	000012AE	H'00000066	0	0	0	0	0
_write	F	00001314	H'00000056	249	16932	498	0	2739
_lseek	F	0000136A	H'00000008	0	0	0	0	0
__INIT_IOLIB	F	00001372	H'00000132	1	1223	79	0	155
__CLOSEALL	F	000014A4	H'00000070	1	1013	68	0	24
_sbrk	F	00001514	H'00000038	0	0	0	0	0
__INITSCT	F	0000154C	H'00000000	1	3414	12	0	379
__slow_strcmp1	F	000015B4	H'00000000	6	337	46	0	0

Figure 3.38 List Sheet

Clicking the column header sorts the items in an alphabetical or ascending/descending order. Clicking the [Function/Variable] or [Address] column displays the source program corresponding to the address in the line.

Right-clicking on the mouse within the window displays a pop-up menu. For details on this pop-up menu, refer to section 3.6.8, Tree Sheet.

3.6.8 Tree Sheet

This sheet displays the relation of function calls along with the profile data that are values when the function is called. This sheet is available when [Disable Tree (Not traces function call)] is not selected from the pop-up menu in the [Profile] window.

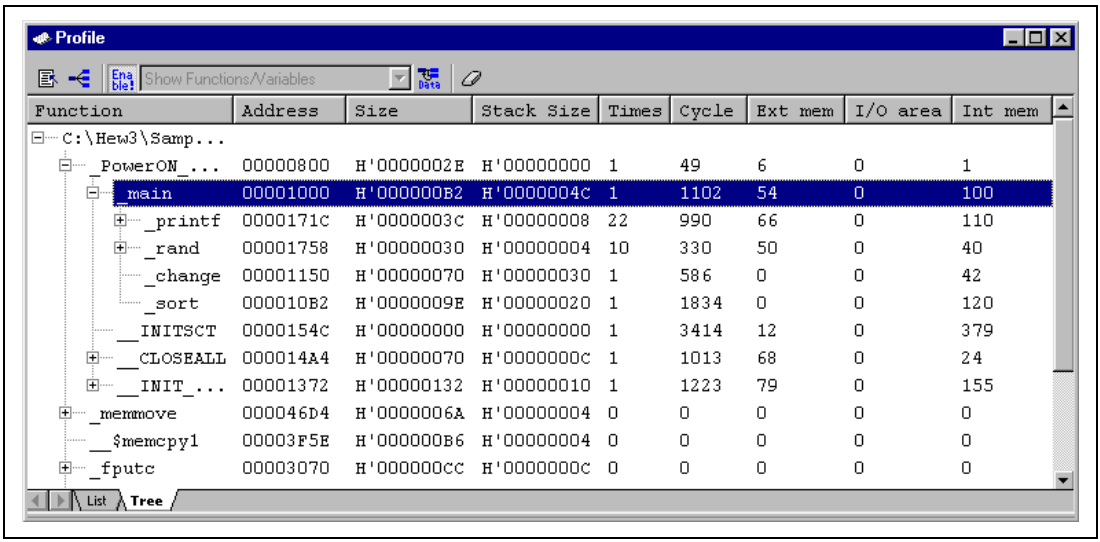


Figure 3.39 Tree Sheet

Double-clicking a function in the [Function] column expands or reduces the tree structure display. The expansion or reduction is also provided by the "+" or "-" key. Double-clicking the [Address] column displays the source program corresponding to the specific address.

Right-clicking the mouse within the window displays a pop-up menu. Supported menu options are as follows:

- View Source

  Displays the source program or disassembled memory contents for the address in the selected line.
- View Profile-Chart

  Displays the [Profile-Chart] window focused on the function in the specified line.
- Enable Profiler

  Toggles acquisition of profile data. When profile data acquisition is enabled, a check mark is shown to the left of the menu text.

- Not trace the function call

  Stops tracing function calls while profile data is acquired. This menu is used when acquiring profile data of the program in which functions are called in a special way, such as task switching in the OS.

  To display the relation of function calls in the [Tree] sheet of the [Profile] window, acquire profile data without selecting this menu. In addition, do not select this menu when optimizing the program by the optimizing linkage editor using the acquired profile information file.
- Find...

  Displays the [Find Text] dialog box to find a character string in the [Function] column. Search is started by entering a character string to be found in the edit box and clicking [Find Next] or pressing the Enter key.
- Find Data...

  Displays the [Find Data] dialog box.

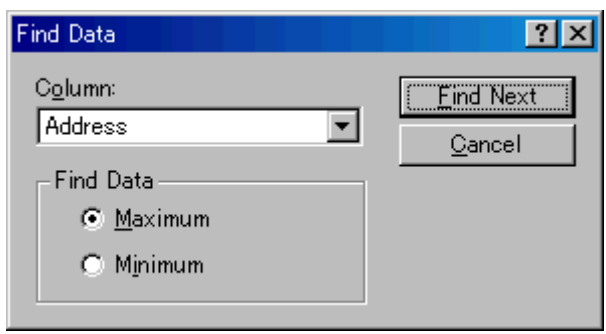


Figure 3.40 Find Data Dialog Box

By selecting the column to be searched in the [Column] combo box and the search type in the [Find Data] group then pressing [Find Next] button or Enter key, search is started. If the [Find Next] button or the Enter key is input repeatedly, the second larger data (the second smaller data when Minimum is specified) is searched for.

- Clear Data

  Clears the number of times functions are called and the profile data. Data in the [List] sheet of the [Profile] window and the data in the [Profile-Chart] window are also cleared.

- Output Profile Information Files...

  Displays the [Save Profile Information Files] dialog box. Profiling results are saved in a profile information file (.pro extension). The optimizing linkage editor optimizes user programs according to the profile information in this file. For details of the optimization using the profile information, refer to the manual of the optimizing linkage editor.

Note: If profile information has been acquired by choosing the [Not trace the function call] menu, the program cannot be optimized by the optimizing linkage editor.

- Output Text File...

  Displays the [Save Text of Profile Data] dialog box. Displayed contents are saved in a text file.
- Setting

  This menu has the following submenus (the menus available only in the [List] sheet are also included).
  - — Show Functions/Variables

    Displays both functions and global variables in the [Function/Variable] column.
  - — Show Functions

    Displays only functions in the [Function/Variable] column.
  - — Show Variables

    Displays only global variables in the [Function/Variable] column.
  - — Only Executed Functions

    Only displays the executed functions. If a stack information file (.sni extension) output from the optimizing linkage editor does not exist in the directory where the load module is located, only the executed functions are displayed even if this check box is not checked.
  - — Include Data of Child Functions

    Sets whether or not to display information for a child function called in the function as profile data.
- Properties...

  This menu cannot be used in this simulator/debugger.

3.6.9 Profile-Chart Window

The [Profile-Chart] window displays the relation of calls for a specific function. This window displays the specified function in the middle, with the callers of the function on the left and the callees of the function on the right. The numbers of times the function calls the functions or is called by the functions are also displayed in this window.

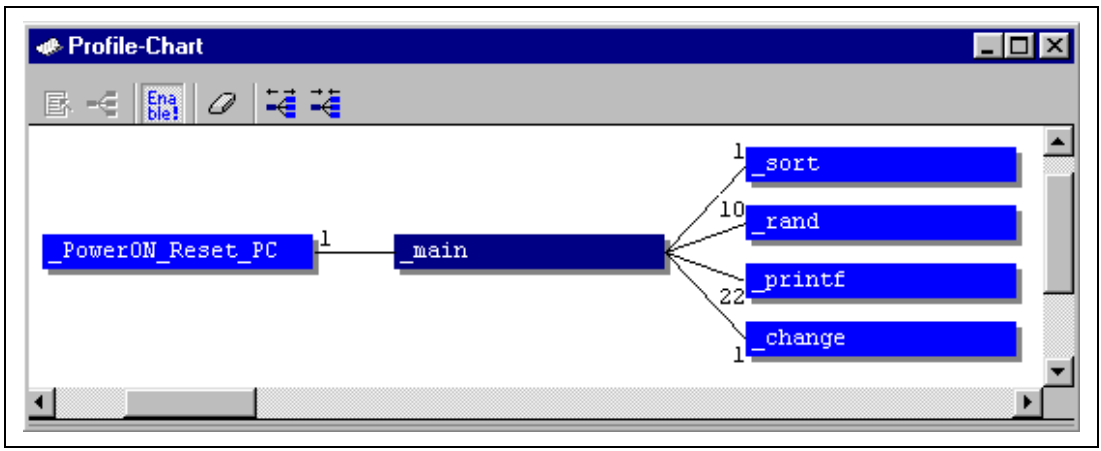


Figure 3.41 Profile-Chart Window

Right-clicking the mouse within the window displays a pop-up menu. Supported menu options are as follows:

- View Source

  Displays the source program or disassembled memory contents for the address of the function on which the cursor is placed when the right-hand mouse button is clicked. If the cursor is not placed on a function when the right-hand mouse button is clicked, this menu option remains gray.
- View Profile-Chart

  Displays the [Profile-Chart] window for the specific function on which the cursor is placed when the right-hand mouse button is clicked. If the cursor is not placed on a function when the right-hand mouse button is clicked, this menu option remains gray.
- Enable Profiler

  Toggles acquisition of profile data. When profile data acquisition is enabled, a check mark is shown to the left of the menu text.

- Clear Data

  Clears the number of times functions are called. Data in the [List] and [Tree] sheets of the [Profile] window are also cleared.
- Multiple View

  If a further [Profile-Chart] window is opened while an existing [Profile-Chart] window is already open, this option selects whether a new window is opened or the new data is displayed in the existing window. When a check mark is shown to the left of this menu item, a new window will be opened.
- Output Profile Information Files...

  Displays the [Save Profile Information Files] dialog box. Profiling results are saved in a profile information file (.pro extension). The optimizing linkage editor optimizes user programs according to the profile information in this file. For details on optimization with the profile information, refer to the user's manual for the optimizing linkage editor.
- Expands Size

  Redo the display with larger intervals between functions. The "+" key can also be used to do this.
- Reduces Size

  Redo the display with smaller intervals between functions. The "-" key can also be used to this.

3.6.10 Types and Purposes of Displayed Data

The profile function is able to acquire the following information:

Address	You can view the locations in memory to which the functions are allocated. Sorting the list of functions and global variables in order of their addresses allows the user to view the way the items are allocated in the memory space.
Size	Sorting in order of size makes it easy to find small functions that are frequently called. Setting such functions as inline may reduce the overhead of function calls. If you are using a device which incorporates a cache memory, greater amount of cache memory will need to be updated when you execute larger functions. This information allows you to check if those functions that may cause cache misses are frequently called.
Stack Size	When there is deep nesting of function calls, pursue the route of the function calls and obtain the total stack size for all of the functions on that route to estimate the amount of stack being used.

Times	Sorting by the number of calls or accesses makes it easy to identify the frequently called functions and frequently accessed global variables.
Profile Data	Measurement of a variety of CPU-specific data is also available as follows:

- SH-1/SH-2/SH-2E Series, SH2-DSP (SH7410), SH-2DSP (Core), and SH2-DSP (SH7065):
  [Cycle] (the number of execution cycles),
  [Ext_mem] (the number of external memory accesses),
  [I/O_area] (the number of internal I/O area accesses),
  [Int_mem] (the number of internal memory accesses)
- SH-3/SH-3E/SH3-DSP Series and SH2-DSP (SH7612):
  [Cycle] (the number of execution cycles),
  [Cache miss] (the number of cache misses),
  [Ext_mem] (the number of external memory accesses),
  [I/O_area] (the number of internal I/O area accesses),
  [Int_mem] (the number of internal memory accesses)
- SH2A-FPU, SH-4 Series and the SH-4A Series:
  [Cycle] (the number of execution cycles),
  [ICache miss] (the number of instruction cache misses),
  [OCache miss] (the number of operand cache misses),
  [Ext_mem] (the number of external memory accesses),
  [I/O_area] (the number of internal I/O area accesses),
  [Int_mem] (the number of internal memory accesses)

The number of execution cycles and cache misses are calculated by subtracting the total execution cycles or cache misses at a specific function call instruction execution from the total execution cycles or cache misses at a return instruction execution of a specific function.

3.6.11 Creating Profile Information Files

To create a profile information file, choose the [Output Profile Information Files…] menu option from the pop-up menu. The [Save Profile Information Files] dialog box is displayed. Pressing the [Save] button after selecting a file name will write the profile information to the selected file. Pressing the [Save All] button will write the profile information to all of the profile information files.

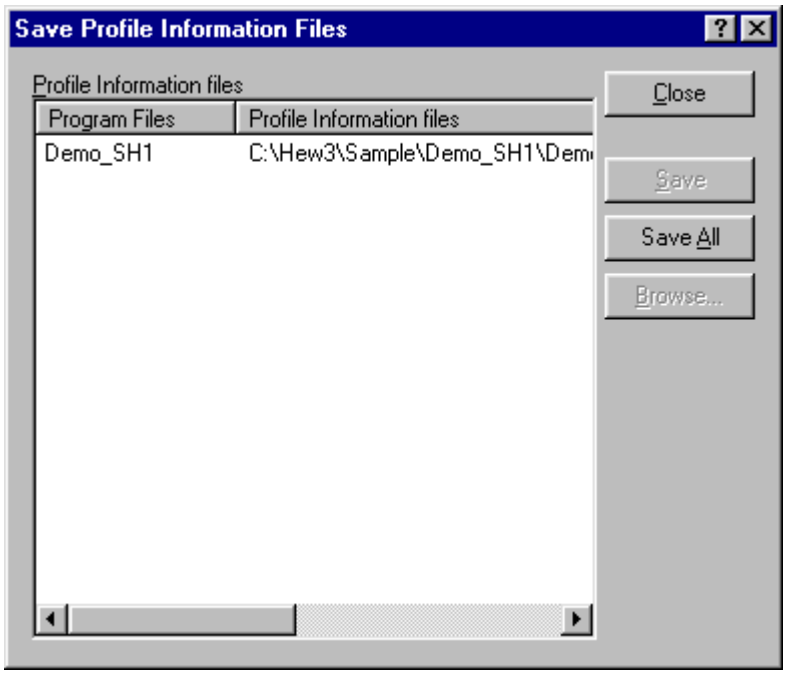


Figure 3.42 Save Profile Information Files Dialog Box

3.6.12 Notes

1. The number of executed cycles for an application program as measured by the profile function includes a margin of error. The profile function only allows the measurement of the proportions of execution time that the functions occupy in the overall execution of the application program. Use the Performance Analysis function to precisely measure the numbers of executed cycles.
2. The names of the corresponding functions may not be displayed when the profile information on a load module with no debugging information is measured.
3. The stack information file (extension: .SNI) must be in the same directory as the load module file (extension: .ABS).
4. It is not possible to store the results of measurement.
5. It is not possible to modify the results of measurement.

3.7 Analyzing Performance

Use the [Performance Analysis] window to select a function name and analyze the performance.

3.7.1 Opening the Performance Analysis Window

Choose [View -> Performance -> Performance Analysis] or click the [PA] toolbar button to open the [Performance Analysis] window.

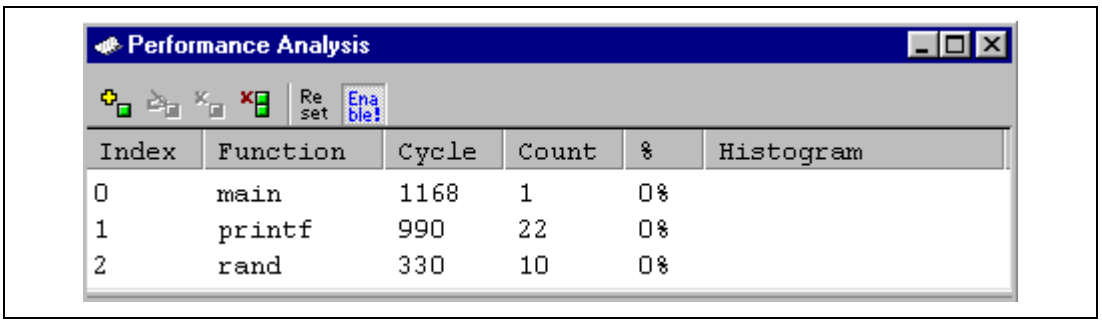


Figure 3.43 Performance Analysis Window

This window displays the number of execution cycles required for each specified function.

The number of execution cycles is calculated as follows:

Execution cycles = total number of execution cycles when execution returns from the function
– total number of execution cycles when the target function is called

The following items are displayed:

[Index] Index number of the set condition

[Function] Name of the function to be measured (or the start address of the function)

[Cycle] Total number of instruction execution cycles

[Count] Total number of calls for the function

[%] Ratio of execution cycle count required for the function to the execution cycle count required for the whole program

[Histogram] Histogram display of the above ratio

3.7.2 Specifying a Target Function

After the [Performance Analysis] window is open, choose [Add Range...] from the pop-up menu or press the Insert key to open the [Performance Option] dialog box, which allows the user to specify a function to be analyzed.

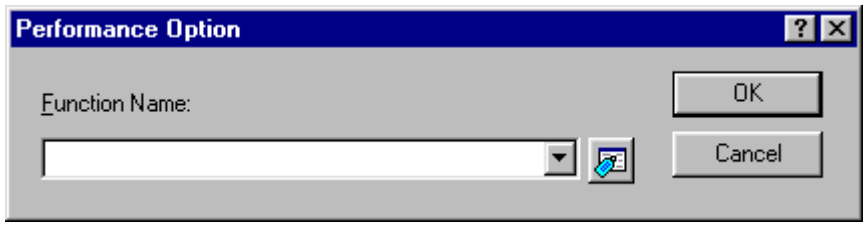


Figure 3.44 Performance Option Dialog Box

This dialog box specifies a function (including a label) to be evaluated. Up to 255 functions can be specified in total.

Clicking the [OK] button stores the setting. Clicking the [Cancel] button closes this dialog box without setting the function to be evaluated.

Select a function that has been set and choose [Edit Range] from the pop-up menu or press the Enter key to open the [Performance Option] dialog box and to change the function to be evaluated.

3.7.3 Starting Performance Data Acquisition

Choose [Enable Analysis] from the pop-up menu to start acquiring performance analysis data.

3.7.4 Resetting Data

Choose [Reset Counts/Times] from the pop-up menu to clear the current performance analysis data.

3.7.5 Deleting a Target Function

Select a function and choose [Delete Range] from the pop-up menu to delete the selected target function and to recalculate the data within other ranges. The selected function can also be deleted by the Delete key.

3.7.6 Deleting All Target Functions

Choose [Delete All Ranges] from the pop-up menu to delete all the current target functions to be evaluated and to clear the performance analysis data.

3.7.7 Saving the Currently Displayed Contents

The contents currently displayed in the window can be saved in a text file. Select [Save to File…] from the pop-up menu.

3.8 Acquiring Code Coverage

The [Coverage] window acquires code coverage information (C0 coverage and C1 coverage) in the range specified by the user, and displays the information.

3.8.1 Opening the Coverage Window

Choose [View -> Code -> Coverage...] or click the [Coverage] toolbar button to open the [Coverage Setting] dialog box.

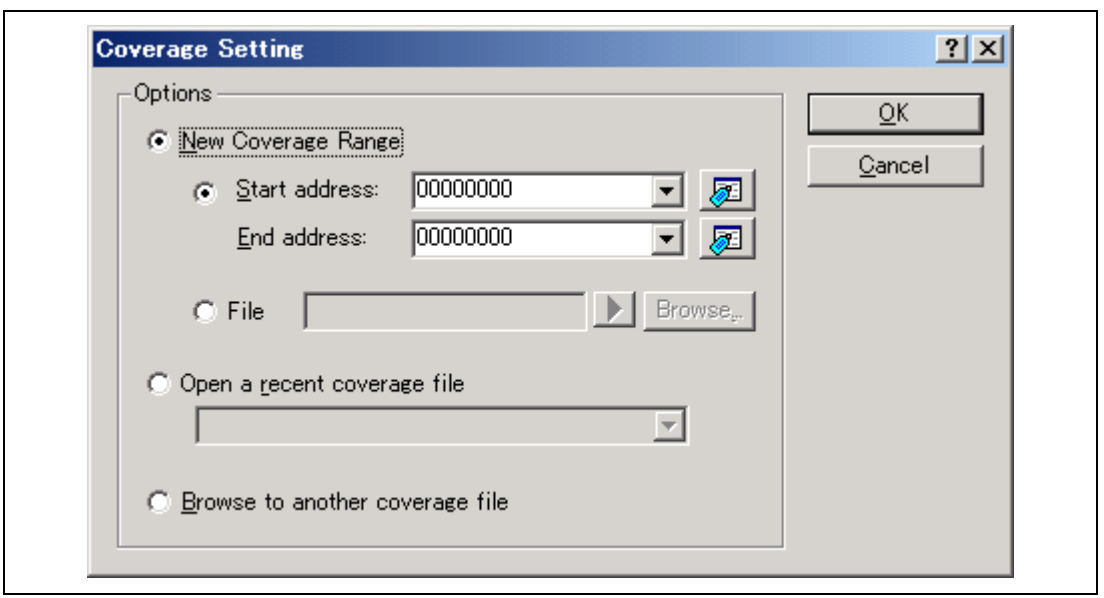


Figure 3.45 Coverage Setting Dialog Box

This dialog box specifies the coverage acquiring range. To set coverage for a new range, the following two ways are available:

- Specifying the start and end addresses on the new coverage range

[Start Address] Start address of coverage information display
(When a prefix is omitted, values input are taken as hexadecimal.)

[End Address] End address of coverage information display
(When a prefix is omitted, values input are taken as hexadecimal.)

- Specifying the file on the new coverage range

[File] Source file whose extension is .C or .CPP in the current project.
Functions in the specified file can be set as the coverage range.
If the extension of the file is omitted, .C is complemented.
The file that has other extensions than .C or .CPP cannot be specified.
A placeholder or the [Browse…] button is available.

To use the settings saved in a coverage information file, choose the file from [Open a recent coverage file], or open a file open dialog box by [Browse to another coverage file] and select the file. When [Open a recent coverage file] is selected, up to four recent files that have been saved are displayed.

Clicking [OK] opens the [Coverage] window.

When the [Coverage] window has already been displayed for specifying address, settings are added in the window.

- Coverage window (specifying address)

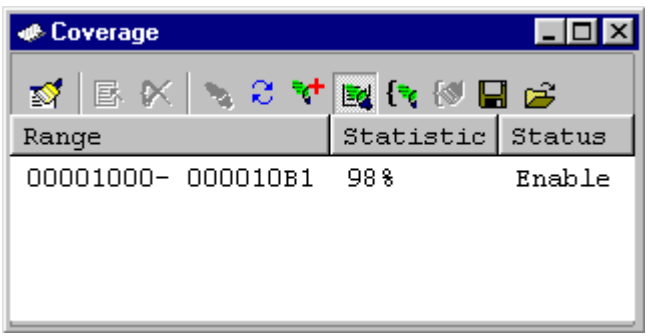


Figure 3.46 Coverage Window (Specifying Address)

This window displays the coverage range and statistical information. The following items are displayed:

[Range] Address range

[Statistic] Percentage of the instruction executed within the function

[Status] Enabled or Disable status of the coverage range

When the [Coverage] window is closed, the acquired coverage information and the conditions to acquire information will be cleared.

- Coverage window (specifying source file)

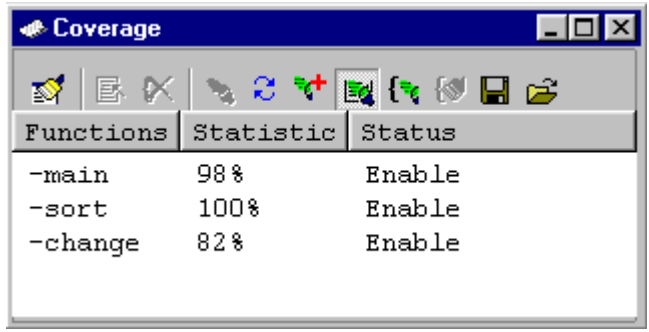


Figure 3.47 Coverage Window (Specifying Source File)

This window displays the coverage range and statistical information. The following items are displayed:

[Functions] List of functions

[Statistic] Percentage of the instruction executed within the function

[Status] Enable or Disable status of the respective function

Note: The functions can be sorted by their names or percentage, either in ascending or descending order, by clicking the column tab ([Functions] or [Statistic]).

When the [Coverage] window is closed, the acquired coverage information and the conditions to acquire information will be cleared.

3.8.2 Acquiring All Coverage Information

Choose [Enable All] from the pop-up menu and execute the user program to acquire all coverage information. By default, [Enable All] is selected.

3.8.3 Clearing All Coverage Information

Choosing [Clear All] from the popup menu clears all the coverage information that has been acquired.

3.8.4 Viewing the Source Window

Choose [View Source] from the pop-up menu to open the [Editor] window and to display the [Editor] window corresponding to the cursor location in the [Coverage] window.

3.8.5 Specifying the New Coverage Range

Choose [Add Range...] from the pop-up menu to open the [Coverage Setting] dialog box (figure 3.45). For the [Coverage Setting] dialog box, refer to section 3.8.1, Opening the Coverage Window.

3.8.6 Changing the Coverage Range

- Specifying the coverage range with an address

Choose the coverage range and [Edit Range...] from the pop-up menu to open the [Coverage Range] dialog box.

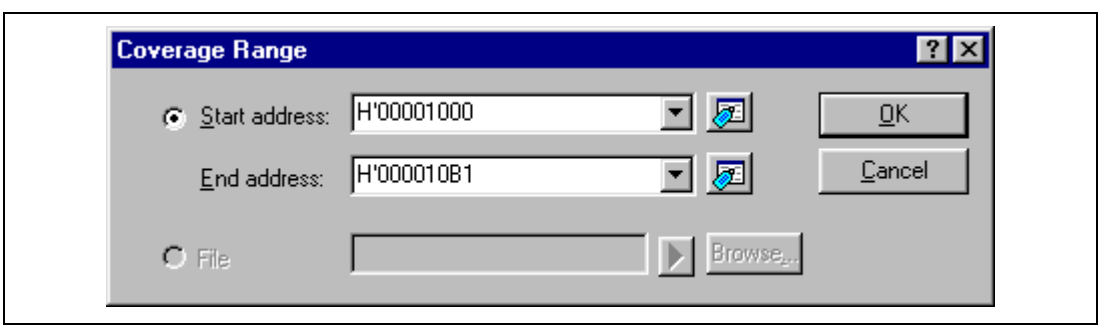


Figure 3.48 Coverage Range Dialog Box (Specifying Address)

This dialog box specifies the condition to acquire instruction execution information. The following items can be specified.

[Start address] Start address (When a prefix is omitted, values input are taken as hexadecimal.)

[End address] End address (When a prefix is omitted, values input are taken as hexadecimal.)

Clicking [OK] changes the coverage range.

- Specifying the coverage range with a source file

Choose [Edit Range...] from the pop-up menu to open the [Coverage Range] dialog box.

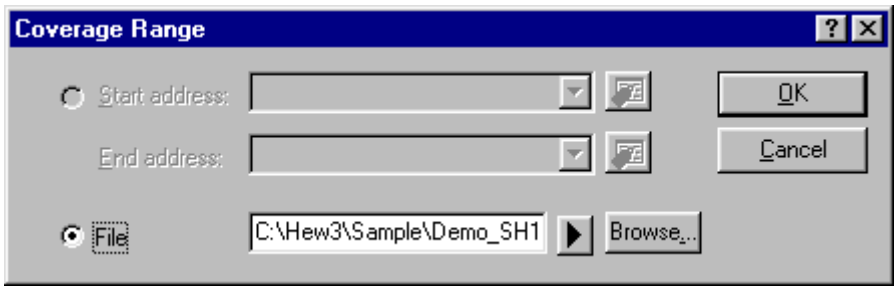


Figure 3.49 Coverage Range Dialog Box (Specifying Source File)

This dialog box specifies the condition to acquire instruction execution information. The following items can be specified.

[File] Source file whose extension is .C or .CPP in the current project.
Functions in the specified file can be set as the coverage range.
If the extension of the file is omitted, .C is complemented.
The file that has other extensions than .C or .CPP cannot be specified.
A placeholder or the [Browse…] button is available.

Clicking [OK] changes the coverage range.

3.8.7 Deleting the Selected Coverage Range

Select a coverage range and choose [Delete Range] from the pop-up menu to delete the selected coverage range.

3.8.8 Acquiring Coverage Information

Specify a coverage range, choose [Enable Coverage] from the pop-up menu, and execute the user program to acquire coverage information. By default, [Enable Coverage] is selected.

3.8.9 Clearing Coverage Information

Specify a coverage range and choose [Clear Data] from the pop-up menu to clear the acquired coverage information.

3.8.10 Saving Coverage Information in a File

Choose [Save Data...] from the pop-up menu to open the [Save Data] dialog box, which allows the user to save the coverage information in a file.

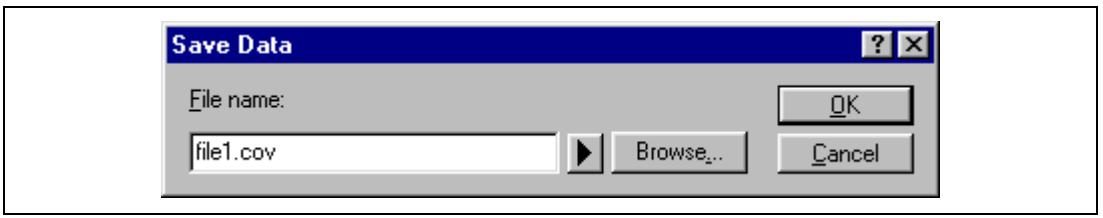


Figure 3.50 Save Data Dialog Box

This dialog box specifies the location and name of a coverage information file to be saved. The placeholder or the [Browse...] button can be used.

If a file name extension is omitted, .COV is automatically added. If a file name extension other than .COV or .TXT is specified, an error message will be displayed.

3.8.11 Loading Coverage Information from a File

Choose [Load Data...] from the pop-up menu to open the [Load Data] dialog box, which allows the user to load the coverage information from a file.

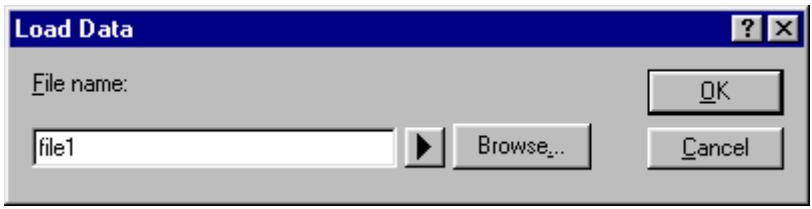


Figure 3.51 Load Data Dialog Box

This dialog box specifies the location and name of a coverage information file to be loaded. The placeholder or the [Browse...] button can be used.

Only .COV files can be loaded. If a file name extension other than .COV is specified, an error message will be displayed.

3.8.12 Updating the Information

Choose [Refresh] from the pop-up menu to update the [Coverage] window to the latest information.

3.8.13 Confirmation Request Dialog Box

A confirmation request dialog box will appear when [Clear All], [Clear Data], [Edit Range...], or [Delete Range] is clicked or an attempt is made to close the [Coverage] window.

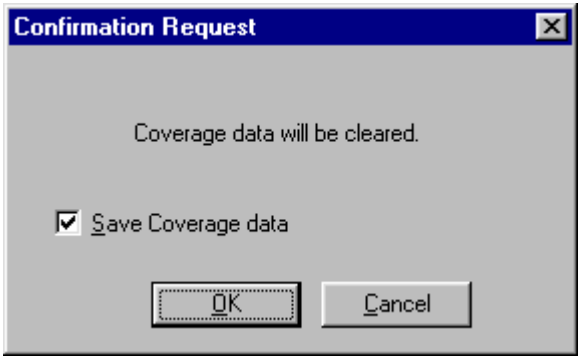


Figure 3.52 Confirmation Request Dialog Box

Clicking [OK] clears the coverage data. Choosing [Save Coverage data] opens the [Save Data] dialog box (figure 3.50) to save the coverage data in a file before it is cleared.

3.8.14 Save Coverage Data Dialog Box

When [File -> Save Session] menu option is clicked, the [Save Coverage Data] dialog box will appear, which allows the user to save the [Coverage] window data in separate files or a single file.

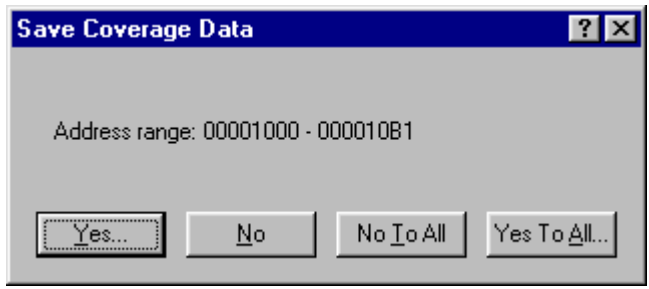


Figure 3.53 Save Coverage Data Dialog Box

When multiple [Coverage] windows are open, a [Save Coverage Data] dialog box will appear for each open coverage window.

Clicking the [No To All] button closes the dialog box without saving any coverage data.

Clicking the [Yes To All] button saves the data of all [Coverage] windows in a single file.

Note: If a file is specified for the coverage range, not all [Coverage] windows can be saved in a single file.

3.8.15 Displaying the Coverage Information in the [Editor] Window

The coverage information is reflected to the [Editor] window by highlighting the [Coverage] columns corresponding to the source lines of executed instructions. When the coverage settings are modified in the [Coverage] window, the [Coverage] column display will be updated.

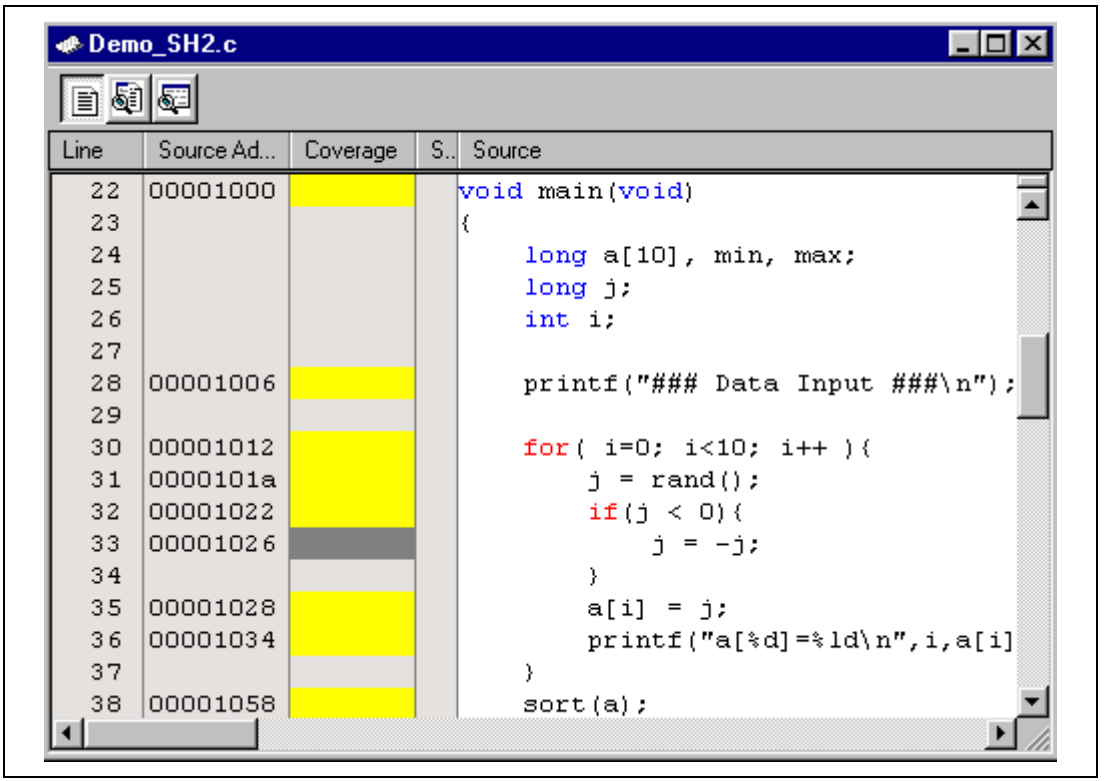


Figure 3.54 Coverage Column (Source)

3.8.16 Displaying the Coverage Information in the [Disassembly] Window

The coverage information is reflected to the [Disassembly] window by highlighting the [Coverage – ASM] columns corresponding to the disassembly lines of executed instructions. When the coverage settings are modified in the [Coverage] window, the [Coverage – ASM] column display will be updated.

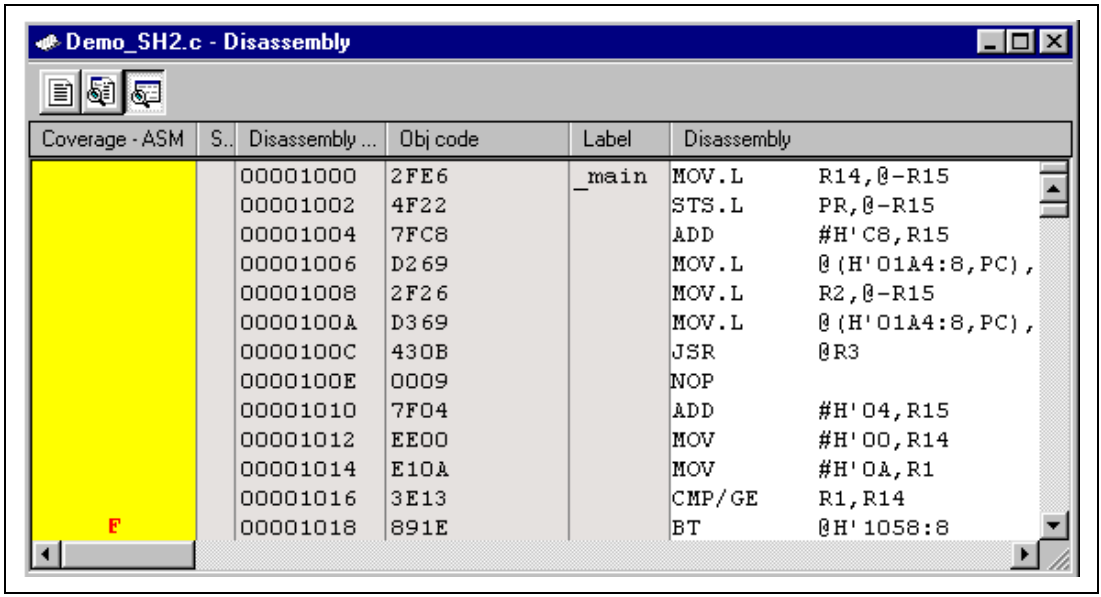


Figure 3.55 Coverage Column (Disassembly)

3.9 Generating a Pseudo-Interrupt Manually

Windows [Trigger] and [GUI I/O] allow the user to generate a pseudo-interrupt manually by pressing a button on the window.

3.9.1 [Trigger] Window

Choose [View -> CPU -> Trigger] or click the [Trigger] toolbar button to open the [Trigger] window.

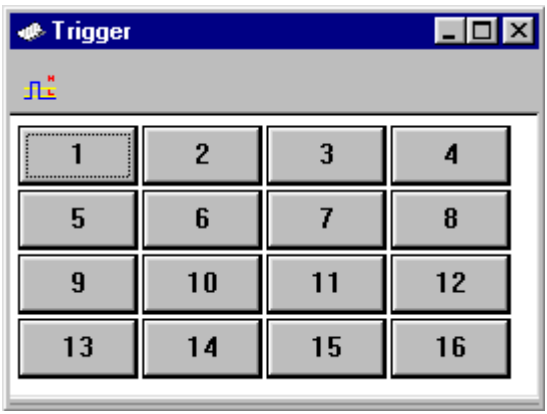


Figure 3.56 Trigger Window

This window displays trigger buttons that generate pseudo-interrupts manually. The details of the interrupt to be generated by pressing each trigger button can be specified in the [Trigger Setting] dialog box.

Up to 256 trigger buttons can be used.

For details on the interrupt processing in the simulator/debugger, refer to section 2.20, Pseudo-Interrupts.

- Setting a trigger button

Choose [Setting...] from the pop-up menu to open the [Trigger Setting] dialog box.

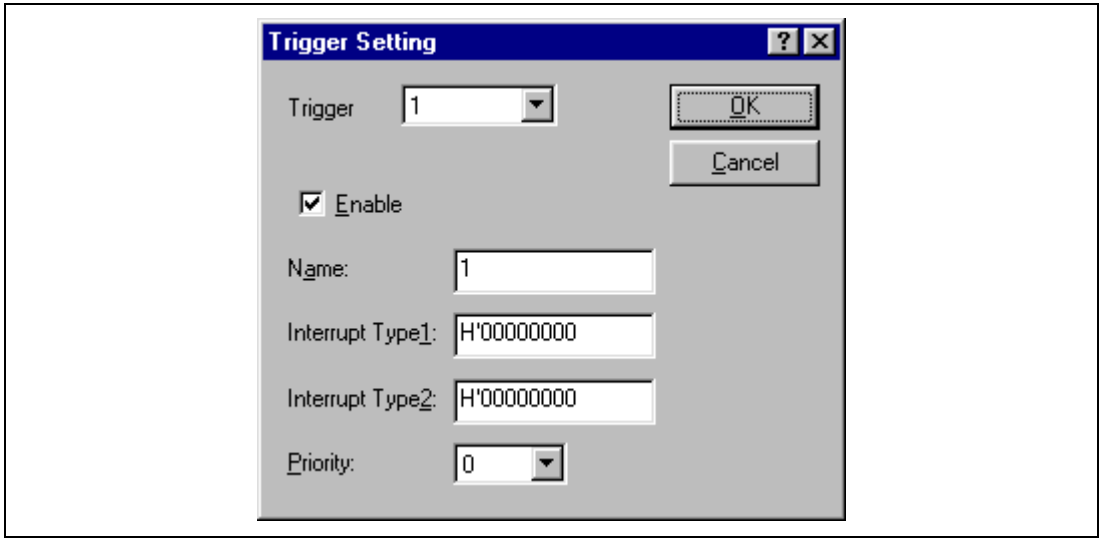


Figure 3.57 Trigger Setting Dialog Box

This dialog box allows the user to specify the details of the pseudo-interrupt to be generated by pressing each trigger button.

[Trigger] Selects the trigger button to be specified in detail

[Name] Specifies a name for the selected trigger button; the name will be displayed in the [Trigger] window

[Enable] Checking this box enables the trigger button.

[Interrupt Type1] Sets the following values for each CPU
- SH-1, SH-2, and SH2-DSP series
  Interrupt vector number
- SH2A-FPU
  Interrupt vector number
- SH-3, SH-4, and SH3-DSP series
  INTEVT (H'0 to H'FFF)
- SH-4A series
  INTEVT (H'0 to H'3FFF)

[Interrupt Type2] Only selectable for the SH3-DSP series: INTEVT2 (H'0 to H'FFF)

[Priority] Interrupt priority (H'0 to H'11; when the prefix is omitted, values input are taken as hexadecimal, and the display is in hexadecimal notation).
When H'10 is specified, the interrupt is always accepted regardless of the value of the I bit value in SR, but is masked by the BL bit in SR. When H'11 is specified, the interrupt is always accepted regardless of the I and BL bit values in SR.

Clicking the [OK] button stores the setting. Clicking the [Cancel] button closes this dialog box without setting the details of the interrupt.

Note: If the [Cancel] button is clicked after multiple trigger button settings are modified, the modifications of all those buttons are canceled.

- Changing the number of trigger buttons

Specify the number of trigger buttons displayed in the [Trigger] window in the [Number of Buttons] submenu in the pop-up menu. [4], [16], [64], or [256] can be selected.

- Changing the size of trigger buttons

Specify the size of trigger buttons displayed in the [Trigger] window in the [Size] submenu in the pop-up menu. [Large], [Normal], or [Small] can be selected.

3.9.2 [GUI I/O] Window

Choose [View -> Graphic -> GUI I/O] or click the [GUI I/O] toolbar button to open the [GUI I/O] window.

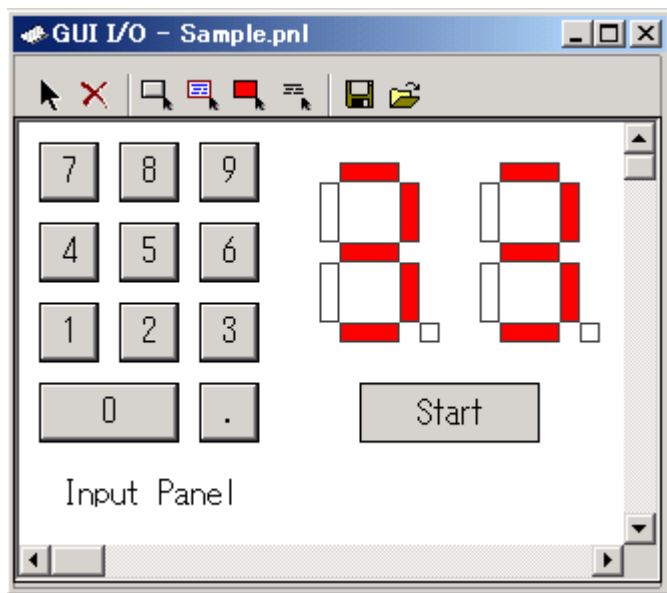


Figure 3.58 GUI I/O Window

This window displays buttons that generate pseudo-interrupts manually. The details of the interrupt to be generated by pressing each button can be specified in the [Set Button] dialog box.

For details on the interrupt processing in the simulator/debugger, refer to section 2.20, Pseudo-Interrupts.

- Setting a button

Choose [Create Button] from the pop-up menu or click the [Create Button] toolbar button ( ). The mouse cursor turns into a "+" symbol. Create the button by dragging the mouse cursor from a higher-left to a lower-right position.

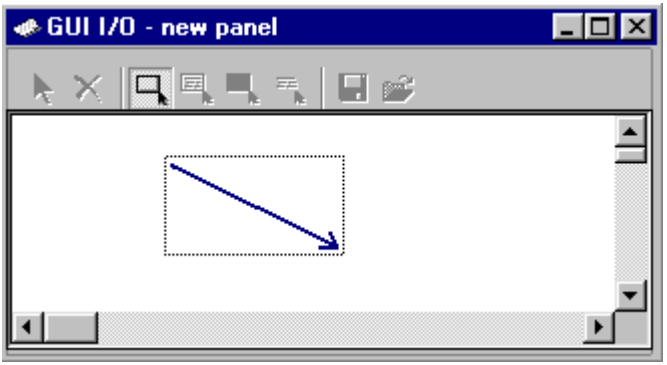


Figure 3.59 GUI I/O Window (Create Button)

Double-click the created button to open the [Set Button] dialog box.

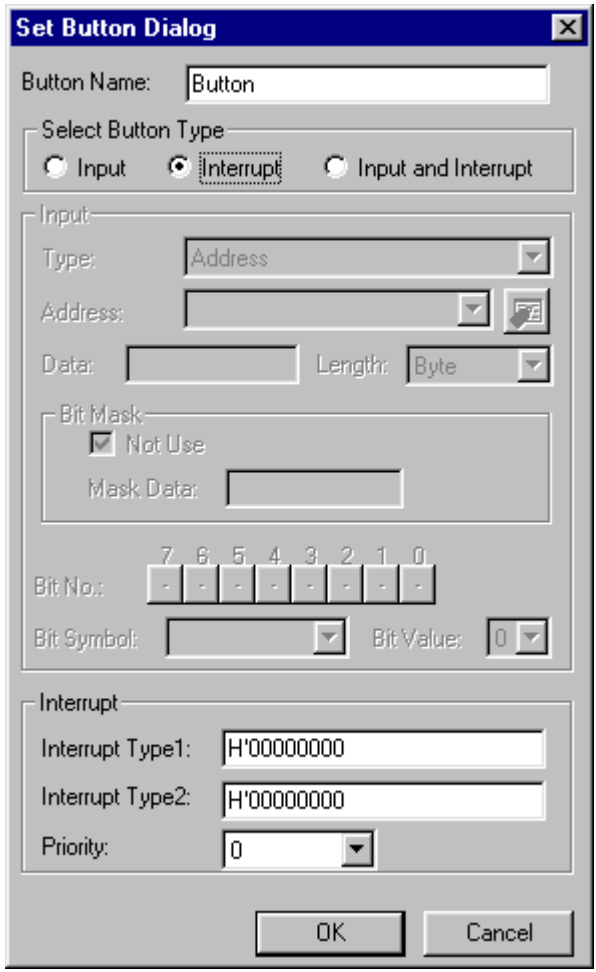


Figure 3.60 Set Button Dialog Box

This dialog box allows the user to specify the details of the pseudo-interrupt to be generated by pressing each button.

[Button Name] Specifies a name for the button; the name will be displayed in the [GUI I/O] window

[Select Button Type] Select [Input] or [Input and Interrupt].

[Interrupt] [Interrupt Type1] Sets the following values for each CPU
- SH-1, SH-2, and SH2-DSP series
  Interrupt vector number
- SH2A-FPU
  Interrupt vector number
- SH-3, SH-4, and SH3-DSP series
  INTEVT (H'0 to H'FFF)
- SH-4A series
  INTEVT (H'0 to H'3FFF)

[Interrupt Type2] Only selectable for the SH3-DSP series:
INTEVT2 (H'0 to H'FFF)

[Priority] Interrupt priority (H'0 to H'11; when the prefix is omitted, values input are taken as hexadecimal, and the display is in hexadecimal notation).
When H'10 is specified, the interrupt is always accepted regardless of the value of the I bit value in SR, but is masked by the BL bit in SR. When H'11 is specified, the interrupt is always accepted regardless of the I and BL bit values in SR.

3.10 Standard I/O and File I/O Processing

Use the [Simulated I/O] window to enable the simulation for standard I/O and file I/O from the user program.

3.10.1 Opening the Simulated I/O Window

Choose [View -> CPU -> Simulated I/O] or click the [Simulated I/O] toolbar button to open the [Simulated I/O] window.

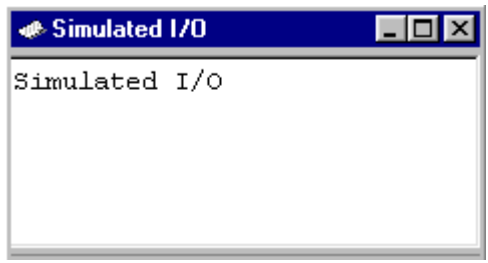


Figure 3.61 Simulated I/O Window

The standard output from the user program is displayed in this window. The key input from this window is handled as the standard input to the user program.

3.10.2 I/O Functions

Table 3.1 lists the supported I/O functions.

Table 3.1 I/O Functions

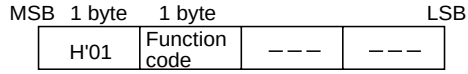
No.	Function Code	Function Name	Description
1	H'21	GETC	Inputs one byte from the standard input
2	H'22	PUTC	Outputs one byte to the standard output
3	H'23	GETS	Inputs one line from the standard input
4	H'24	PUTS	Outputs one line to the standard output
5	H'25	FOPEN	Opens a file
6	H'06	FCLOSE	Closes a file
7	H'27	FGETC	Inputs one byte from a file
8	H'28	FPUTC	Outputs one byte to a file
9	H'29	FGETS	Inputs one line from a file
10	H'2A	FPUTS	Outputs one line to a file
11	H'0B	FEOF	Checks for end of file
12	H'0C	FSEEK	Moves the file pointer
13	H'0D	FTELL	Returns the current position of the file pointer

To perform I/O processing, use the [Simulated I/O Address] in the [Simulator System] dialog box (refer to section 3.2.1, Modifying the Simulator System) in the following procedure.

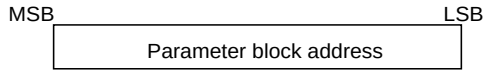
1. Set the address specialized for I/O processing in the [System Call Address], select [Enable] and execute the program.
2. When detecting a subroutine call instruction (BSR, JSR, or BSRF), that is, a simulated I/O instruction to the specified address during user program execution, the simulator/debugger performs I/O processing by using the R0 and R1 values as the parameters.

Therefore, make the following settings in the user program before issuing a simulated I/O instruction:

- Set the function code (table 3.1) to the R0 register



- Set the parameter block address to the R1 register (for the parameter block, refer to each function description)



- Reserve the parameter block and input/output buffer areas

Each parameter of the parameter block must be accessed in the parameter size.

After the I/O processing, the simulator/debugger resumes simulation from the instruction that follows the simulated I/O instruction.

Note: When a JSR, BSR, or BSRF instruction is used as a simulated I/O instruction, the instruction following the JSR, BSR, or BSRF instruction is executed as a normal instruction, not a slot instruction. Therefore, the instruction placed immediately after the simulated I/O instruction (JSR, BSR, or BSRF) must not be one that produces different results depending on whether executed as a normal instruction or as a slot instruction.

Refer to the simulator/debugger help about each I/O function.

The following shows an example for inputting one character as a standard input (from a keyboard).

```
            MOV.L     PAR_ADR,R1
            MOV.L     REQ_COD,R0
            MOV.L     CALL_ADR,R3
            JSR       @R3
            NOP
STOP        NOP
SYS_CALL    NOP
            .ALIGN    4
CALL_ADR    .DATA.L   SYS_CALL
REQ_COD     .DATA.L   H'01210000
PAR_ADR     .DATA.L   PARM
PARM        .DATA.L   INBUF
INBUF       .RES.B    2
            .END
```

3.11 Viewing the TLB Contents

The TLB window is used to display the TLB contents in a CPU with the MMU (Memory Management Unit) function. The TLB window differs depending on the CPU. Read the description corresponding to your CPU.

3.11.1 Opening a TLB Window

SH-3, SH-3E, and SH3-DSP Series:

Choose [View -> CPU -> TLB] or click the [TLB] toolbar button [ ] to open the [TLB] window.

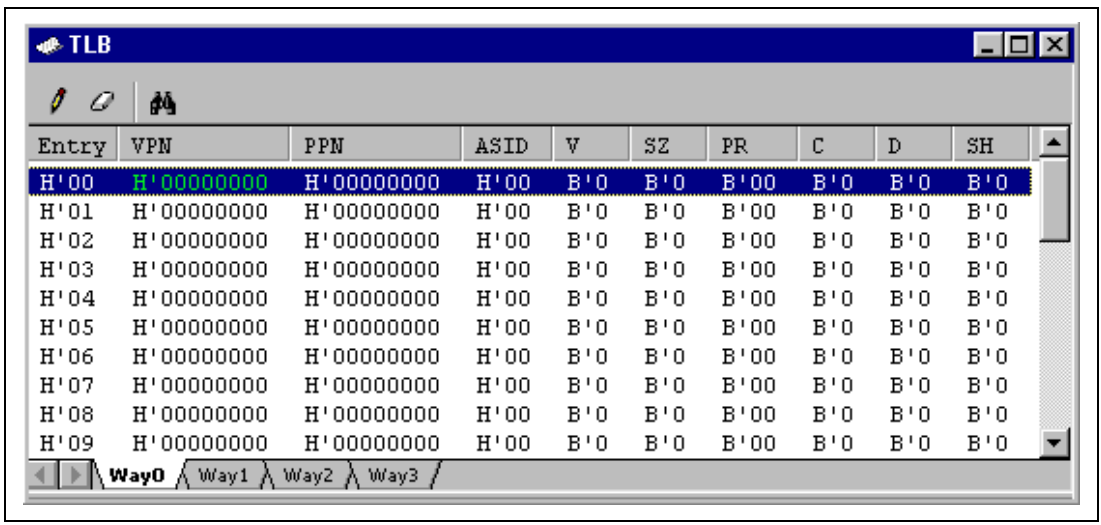


Figure 3.62 TLB Window (SH-3/SH-3E/SH3-DSP Series)

This window displays the TLB contents. The selected entry is displayed in green. Since each way has one sheet, clicking the way's sheet displays the way's contents. The contents of a currently disabled way are grayed out.

The following items are displayed in the window:

[Entry]	Entry number in the TLB (H'00 to H'FF)
[VPN]	Virtual page number (longword). Bits 31 to 10 are valid.
[PPN]	Physical page number (longword). Bits 31 to 10 are valid.
[ASID]	Address space identifier
[V]	Validity bit
[SZ]	Page-size bit
[PR]	Protection key field
[C]	Cacheable bit
[D]	Dirty bit
[SH]	Share status bit

SH-4 Series and SH-4A Series:

The SH-4 series and the SH-4A series have two kinds of TLB windows: instruction TLB window and unified TLB window. The SH-4A series has the PMB window as well as those two windows.

Choose [View -> CPU -> TLB] or click the [TLB] toolbar button [TLB] to open the [Select TLB] dialog box (figure 3.63) for selecting the TLB window type to be displayed.

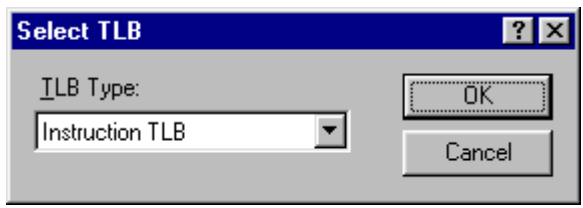


Figure 3.63 Select TLB Dialog Box

This dialog box selects the TLB to be displayed. Select one of the following TLB types:

[Instruction TLB] Opens the instruction TLB window.

[Unified TLB] Opens the unified TLB window.

[PMB] Opens the PMB window (the SH-4A series only)

Clicking the [OK] button displays the selected TLB window. Clicking the [Cancel] button closes the dialog box without opening a TLB window.

- Instruction TLB window

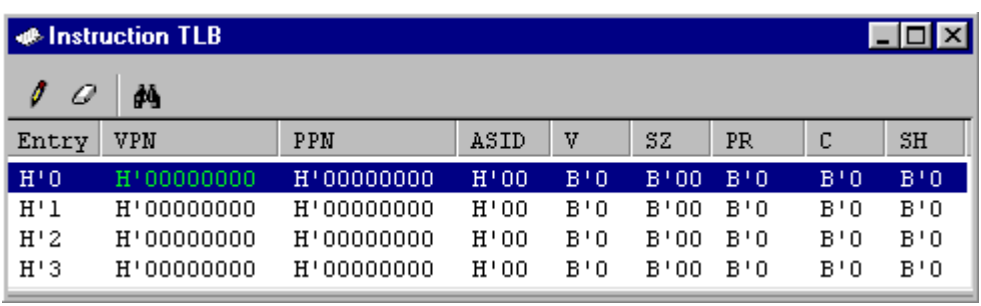


Figure 3.64 Instruction TLB Window (SH-4 Series)

This window displays the instruction TLB contents. The selected entry is displayed in green.

The following items are displayed in the window:

[Entry] Entry number in the instruction TLB (H'0 to H'3)

[VPN] Virtual page number (longword). Bits 31 to 10 are valid.

[PPN] Physical page number (longword). Bits 31 to 10 are valid.

[ASID] Address space identifier

[V] Validity bit

[SZ] Page-size bit

[PR] Protection key field

[C] Cacheable bit

[SH] Share status bit

- Unified TLB window

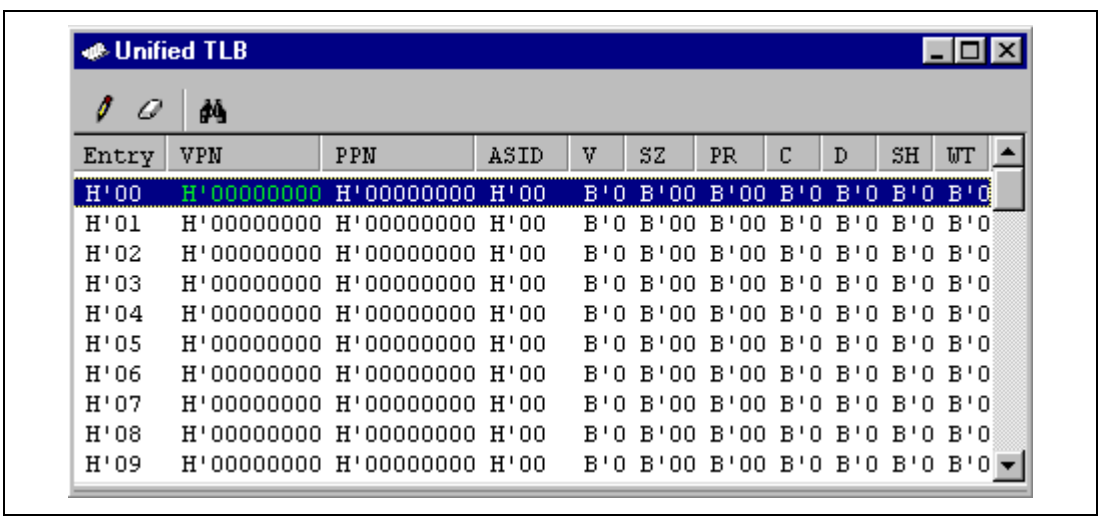


Figure 3.65 Unified TLB Window (SH-4 Series)

This window displays the unified TLB contents. The selected entry is displayed in green.

The following items are displayed in the window:

[Entry]	Entry number in unified TLB (H'00 to H'3F)
[VPN]	Virtual page number (longword). Bits 31 to 10 are valid.
[PPN]	Physical page number (longword). Bits 31 to 10 are valid.
[ASID]	Address space identifier
[V]	Validity bit
[SZ]	Page-size bit
[PR]	Protection key field
[C]	Cacheable bit
[D]	Dirty bit
[SH]	Share status bit
[WT]	Write-through bit

- PMB window

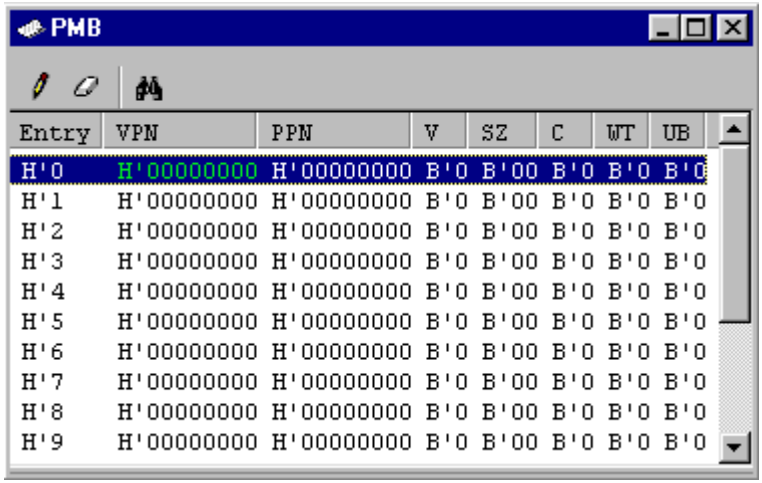


Figure 3.66 PMB Window (SH-4A Series)

This window displays the PMB information and is only supported by the SH-4A series. The selected entry is displayed in green.

The following items are displayed in the window:

[Entry] Entry number in PMB (H'0 to H'F)

[VPN] Virtual page number (longword). Bits 31 to 24 are valid.

[PPN] Physical page number (longword). Bits 31 to 24 are valid.

[V] Validity bit

[SZ] Page-size bit

[C] Cacheable bit

[WT] Write-through bit

[UB] Whether or not to write to the buffer

Note: Some devices do not incorporate the PMB.

3.11.2 Modifying the TLB Contents

Selecting [Modify…] from the pop-up menu with a TLB item selected opens the dialog box to modify the selected TLB item.

Figure 3.67 Modify TLB Dialog Box (VPN is Selected in SH-3)

This dialog box allows the currently selected TLB item to be modified. The selected TLB item and entry number are displayed in the caption of the dialog box. The way number is also displayed for a TLB with ways. The item name in the dialog box displays the selected TLB item.

Clicking the [OK] button stores the newly entered contents in the TLB. Clicking the [Cancel] button closes the dialog box without storing the newly entered contents in the TLB.

A value can be directly input in the window.

3.11.3 Flushing the TLB Contents

Selecting [Flush] from the pop-up menu flushes the TLB. All valid bits are cleared to 0 and all TLB entries are invalidated.

Note that during execution of an instruction, the [Flush] menu is disabled and the TLB cannot be flushed.

3.11.4 Searching the TLB Items

Selecting [Find…] from the pop-up menu opens the [Find TLB] dialog box in which a TLB item can be searched for in column units.

Note that during execution of an instruction, the [Find…] menu is disabled and the TLB item cannot be searched for.

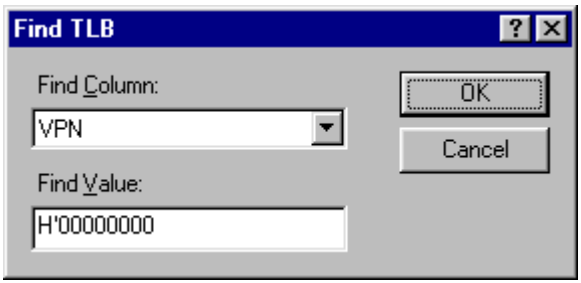


Figure 3.68 Find TLB Dialog Box

This dialog box searches for a TLB item. The following search conditions can be specified:

[Search column] Item to be searched for

[Search value] Value to be searched for

After setting the search conditions, the search can be started by clicking the [OK] button. As a result, the matching entry is highlighted.

Clicking the [Cancel] button closes the dialog box without searching for a TLB item.

3.11.5 Continuing the TLB Search

The next matching TLB item can be searched for with the search conditions that have previously been set. In the state where a matching TLB item was found in the preceding search, select [Find Next] from the pop-up menu.

Note that during execution of an instruction, the [Find Next] menu is disabled and the next matching TLB item cannot be searched for.

3.11.6 Saving the Currently Displayed Contents

The contents currently displayed in the window can be saved in a text file. Select [Save to File…] from the pop-up menu.

3.12 Viewing the Cache Contents

The cache window is used to display the cache contents in a CPU with cache. The cache window differs depending on the CPU. Read the description corresponding to the CPU.

3.12.1 Opening a Cache Window

SH-3, SH-3E, SH3-DSP, and SH2-DSP (SH7612) Series:

Choose [View -> CPU -> Cache] or click the [Cache] toolbar button [ ] to open the [Cache] window.

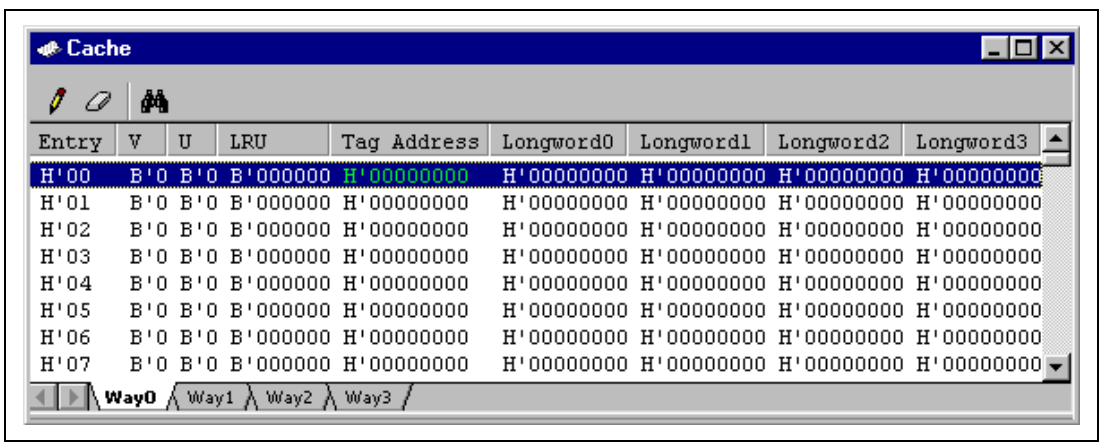


Figure 3.69 Cache Window (SH-3/SH-3E/SH3-DSP/SH2-DSP (SH7612) Series)

This window displays the cache contents. The selected entry is displayed in green. Since each way has one sheet, clicking the way's sheet displays the way's contents. The contents of a currently disabled way are grayed out.

The following items are displayed in the window:

[Entry]	Entry number in the cache. The specifiable value depends on the CPU. • SH-3 and SH-3E series: H'00 to H'7F • SH3-DSP series: H'00 to H'FF • SH2-DSP (SH7612): H'00 to H'3F
[V]	Validity bit. When this bit is 1, the entry is valid.
[U]	Update bit. When this bit is 1, the entry has been written to.
[LRU]	Numerical string that determines which way's entry should be replaced when a cache miss occurs. (The same LRU value is assigned to the same entry in all ways.)
[Tag Address]	Tag address
[Longword0] to [Longword3]	Longword data 0 to 3 set to the cache entry

SH2A-FPU, SH-4 Series, and SH-4A Series:

The SH2A-FPU, SH-4 series, and the SH-4A series have two kinds of cache windows: instruction cache window and operand cache window. In addition, the SH-4A series has the level-2 cache window and the SH2A-FPU has the ROM-cache window.

Choose [View -> CPU -> Cache] or click the [Cache] toolbar button [ ] to open the [Select Cache] dialog box (figure 3.70) for selecting the cache window type to be displayed.

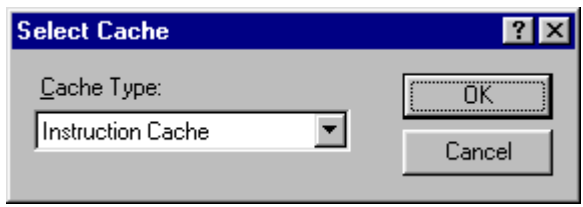


Figure 3.70 Select Cache Dialog Box

This dialog box selects the cache to be displayed. Select one of the following cache types:

[Instruction Cache] Opens the instruction cache window.[*1]

[Operand Cache] Opens the operand cache window.[*1]

[Level-2 Cache] Opens the level-2 cache window (SH-4A only).

[ROM Prefetch Cache] Opens the ROM prefetch cache window (SH2A-FPU only).[*2]

[ROM Prefetch Miss Cache]
Opens the ROM prefetch miss cache window (SH2A-FPU only).[*2]

[ROM Operand Cache] Opens the ROM operand cache window (SH2A-FPU only).[*2]

Notes: 1. For the SH2A-FPU series, this type is only displayed when the internal ROM is invalid.
2. This type is only displayed when the internal ROM is valid.
For specification of the internal ROM of the SH2A-FPU as valid or invalid, refer to section 3.1.2, Setting up a Workspace for the Simulator/Debugger.

Clicking the [OK] button displays the selected cache window. Clicking the [Cancel] button closes the dialog box without opening a cache window.

- Instruction cache window

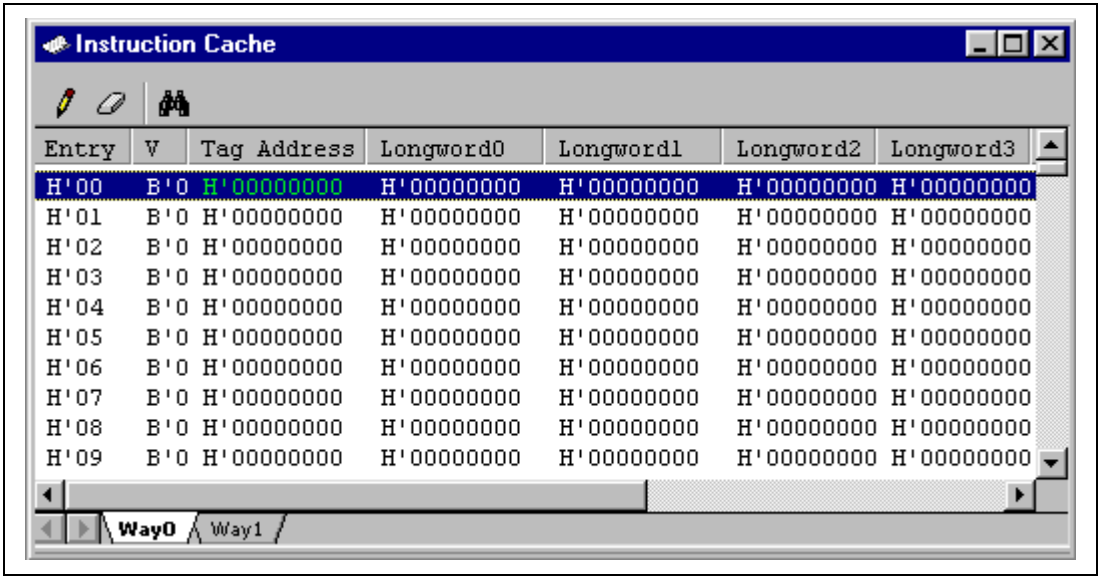


Figure 3.71 Instruction Cache Window (SH-4 (SH7750R))

This window displays the instruction cache contents. The selected entry is displayed in green. Each way has a sheet, and the contents are displayed when the tab for the sheet to be displayed is clicked. Invalid ways are displayed in gray. (The SH-4 and SH-4BSC have only one way.)

The following items are displayed in the instruction cache window:

[Entry]	Entry number in the instruction cache (depends on the cache capacity)
[V]	Validity bit. When this bit is 1, the entry is valid.
[LRU]	Numerical string that determines which way's entry should be replaced when a cache miss occurs. (The same LRU value is assigned to the same entry in all ways.)
[Tag Address]	Tag address
[Longword0] to [Longword7]	Longword data 0 to 7 set to the instruction cache entry. In the SH2A-FPU, longword data 0 to 3.

- Operand cache window

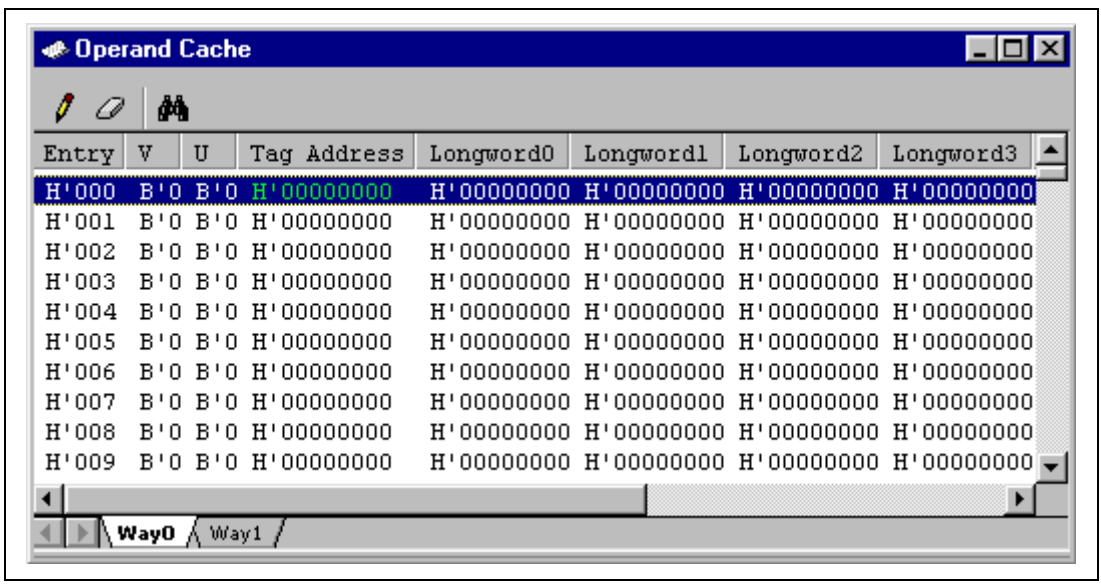


Figure 3.72 Operand Cache Window (SH-4 (SH7750R))

This window displays the operand cache contents. The selected entry is displayed in green. Each way has a sheet, and the contents are displayed when the tab for the sheet to be displayed is clicked. Invalid ways are displayed in gray. (The SH-4 and SH-4BSC have only one way.)

The following items are displayed in the operand cache window:

[Entry]	Entry number in the operand cache (depends on the cache capacity)
[V]	Validity bit. When this bit is 1, the entry is valid.
[U]	Update bit. When this bit is 1, the entry has been written to.
[LRU]	Numerical string that determines which way's entry should be replaced when a cache miss occurs. (The same LRU value is assigned to the same entry in all ways.)
[Tag Address]	Tag address
[Longword0] to [Longword7]	Longword data 0 to 7 set to the operand cache entry. In the SH2A-FPU, longward data 0 to 3.

- Level-2 cache window

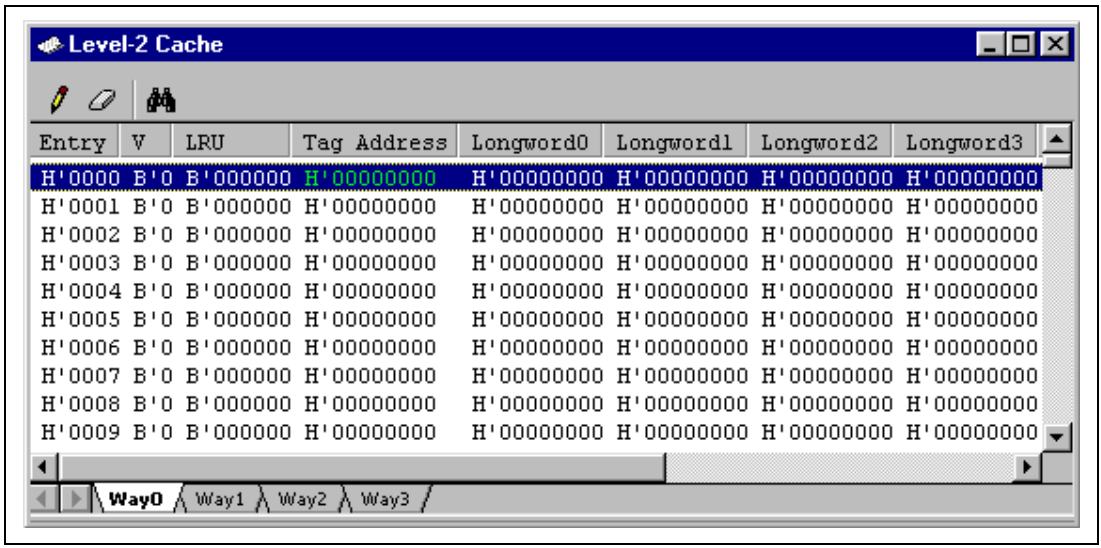


Figure 3.73 Level-2 Cache Window (SH-4A)

This window displays the level-2 cache contents and is only supported by the SH-4A series. The selected entry is displayed in green.

The following items are displayed in the level-2 cache window:

[Entry]	Entry number in the level-2 cache (depends on the cache capacity)
[V]	Validity bit. When this bit is 1, the entry is valid.
[LRU]	Numerical string that determines which way's entry should be replaced when a cache miss occurs. (The same LRU value is assigned to the same entry in all ways.)
[Tag Address]	Tag address
[Longword0] to [Longword7]	Longword data 0 to 7 set to the operand cache entry

Note: Some devices do not incorporate the level-2 cache.

- ROM cache window

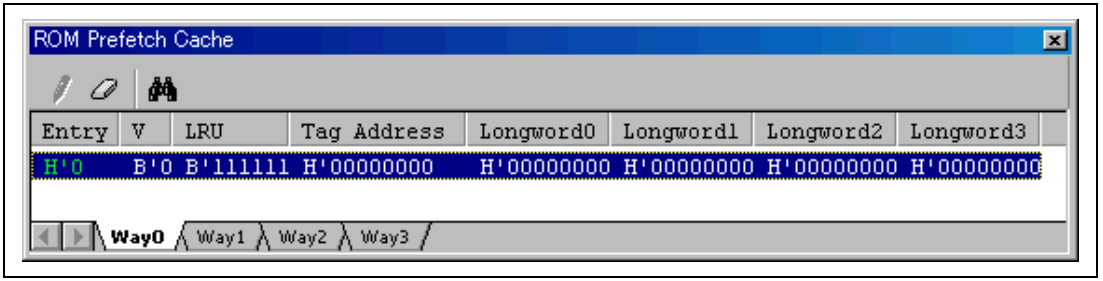


Figure 3.74 ROM Cache Window (Prefetch Cache)

This window displays the ROM cache contents and is only supported by the SH2A-FPU. There are three types of ROM cache windows; ROM prefetch cache window, ROM prefetch miss cache window, and ROM operand cache window. Items displayed in these three windows are the same. The selected entry is displayed in green.

The following items are displayed in the ROM cache window:

[Entry]	Entry number in the ROM cache
[V]	Validity bit. When this bit is 1, the entry is valid.
[LRU]	Numerical string that determines which way's entry should be replaced when a cache miss occurs. (The same LRU value is assigned to the same entry in all ways.)
[Tag Address]	Tag address
[Longword0] to [Longword3]	Longword data 0 to 3 set to the operand cache entry

3.12.2 Modifying the Cache Contents

Selecting [Modify…] from the pop-up menu with a cache item selected opens the dialog box to modify the selected cache item.

Note that during execution of an instruction, the [Modify…] menu is disabled and the cache items cannot be modified.

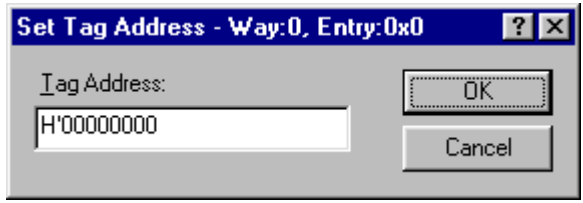


Figure 3.75 Modify Cache Dialog Box (Tag Address is Selected in SH-3)

This dialog box allows the currently selected cache item to be modified. The selected cache item and entry number are displayed in the caption of the dialog box. The way number is also displayed for a cache with ways. The item name in the dialog box displays the selected cache item.

Clicking the [OK] button stores the newly entered contents in the cache. Clicking the [Cancel] button closes the dialog box without storing the newly entered contents in the cache.

A value can be directly input in the window.

3.12.3 Flushing the Cache Contents

Selecting [Flush] from the pop-up menu flushes cache. All V, U, and LRU bits are cleared to 0 and all cache entries are invalidated.

Note that during execution of an instruction, the [Flush] menu is disabled and cache cannot be flushed.

3.12.4 Searching the Cache Items

Selecting [Find…] from the pop-up menu opens the [Find Cache] dialog box in which a cache item can be searched for in column units.

Note that during execution of an instruction, the [Find…] menu is disabled and the cache item cannot be searched for.

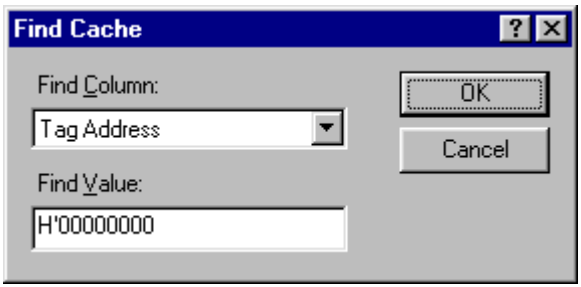


Figure 3.76 Find Cache Dialog Box

This dialog box searches for a cache item. The following search conditions can be specified:

[Find Column] Item to be searched for

[Find Value] Value to be searched for

After setting the search conditions, the search can be started by clicking the [OK] button. As a result, the matching entry is highlighted.

Clicking the [Cancel] button closes the dialog box without searching for a cache item.

3.12.5 Continuing the Cache Search

The next matching cache item can be searched for with the search conditions that have previously been set. In the state where a matching cache item was found in the preceding search, select [Find Next] from the pop-up menu.

Note that during execution of an instruction, the [Find Next] menu is disabled and the next matching cache item cannot be searched for.

3.12.6 Modifying the Cache Capacity

This function is only provided for the SH-3, SH-3E series, and SH-4A series. Selecting [Capacity…] from the pop-up menu opens the [Cache Capacity] dialog box in which the cache capacity can be modified.

Note that during execution of an instruction, the [Capacity…] menu is disabled and the cache capacity cannot be modified.

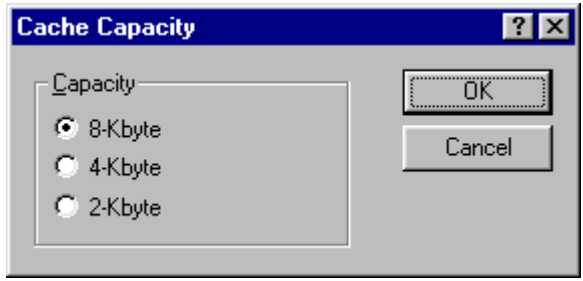


Figure 3.77 Cache Capacity Dialog Box (SH-3/SH-3E Series)

This dialog box allows the cache capacity to be modified.

The following cache capacities can be selected:

[8-Kbyte] 8-Kbyte cache capacity (default)
All four ways, way 0 to way 3 (two ways, way 0 and way 1, when the internal RAM is specified), are valid.

[4-Kbyte] 4-Kbyte cache capacity
Two ways, way 0 and way 1 (one way, way 0, when the internal RAM is specified), are valid.

[2-Kbyte] 2-Kbyte cache capacity
One way, way 0, is valid. The internal RAM specification is ignored.

Clicking the [OK] button modifies the cache capacity. Clicking the [Cancel] button closes the dialog box without modifying the cache capacity.

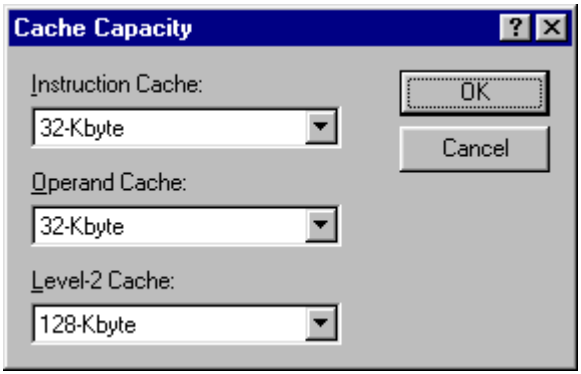


Figure 3.78 Cache Capacity Dialog Box (SH-4A)

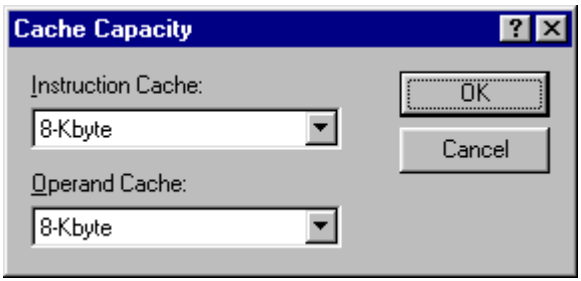


Figure 3.79 Cache Capacity Dialog Box (SH2A-FPU and SH4AL-DSP)

This dialog box allows the cache capacity to be modified.

The following cache capacities can be selected depending on the cache type:

For the SH-4A series:

[Instruction Cache]: Sets the capacity of the instruction cache. Four ways, way 0 to way 3, are all valid, and the number of entry changes. (The number of entries in each way is the same.)

- [8-Kbyte]: 8-Kbyte cache capacity
  (One way: 2 Kbytes, the number of entries: H'000 to H'03F)
- [16-Kbyte]: 16-Kbyte cache capacity
  (One way: 4 Kbytes, the number of entries: H'000 to H'07F)
- [32-Kbyte]: 32-Kbyte cache capacity (default)
  (One way: 8 Kbytes, the number of entries: H'000 to H'0FF)
- [64-Kbyte]: 64-Kbyte cache capacity
  (One way: 16 Kbytes, the number of entries: H'000 to H'1FF)
- [128-Kbyte]: 128-Kbyte cache capacity
  (One way: 32 Kbytes, the number of entries: H'000 to H'3FF)

[Operand Cache]: Sets the capacity of the operand cache. Four ways, way 0 to way 3, are all valid, and the number of entry changes. (The number of entries in each way is the same.)

- [8-Kbyte]: 8-Kbyte cache capacity
  (One way: 2 Kbytes, the number of entries: H'000 to H'03F)
- [16-Kbyte]: 16-Kbyte cache capacity
  (One way: 4 Kbytes, the number of entries: H'000 to H'07F)

[32-Kbyte]: 32-Kbyte cache capacity (default)
(One way: 8 Kbytes, the number of entries: H'000 to H'0FF)

[64-Kbyte]: 64-Kbyte cache capacity
(One way: 16 Kbytes, the number of entries: H'000 to H'1FF)

[128-Kbyte]: 128-Kbyte cache capacity
(One way: 32 Kbytes, the number of entries: H'000 to H'3FF)

[Level-2 Cache] (SH-4A only): Sets the capacity of the level-2 cache. Four ways, way 0 to way 3, are all valid, and the number of entry changes. (The number of entries in each way is the same.)

[128-Kbyte]: 128-Kbyte cache capacity (default)
(One way: 32 Kbytes, the number of entries: H'0000 to H'03FF)

[256-Kbyte]: 256-Kbyte cache capacity
(One way: 64 Kbytes, the number of entries: H'0000 to H'07FF)

[512-Kbyte]: 512-Kbyte cache capacity
(One way: 128 Kbytes, the number of entries: H'0000 to H'0FFF)

[1-Mbyte]: 1-Mbyte cache capacity
(One way: 256 Kbytes, the number of entries: H'0000 to H'1FFF)

For the SH2A-FPU series:

[Instruction Cache]: Sets the capacity of the instruction cache. Four ways, way 0 to way 3, are all valid, and the number of entry changes. (The number of entries in each way is the same.)

- [8-Kbyte] 8-Kbyte cache capacity (One way: 2 Kbytes, the number of entries: H'007F)
- [16-Kbyte] 16-Kbyte cache capacity (One way: 4 Kbytes, the number of entries: H'00FF)
- [32-Kbyte] 32-Kbyte cache capacity (default) (One way: 8 Kbytes, the number of entries: H'01FF)
- [64-Kbyte] 64-Kbyte cache capacity (One way: 16 Kbytes, the number of entries: H'03FF)
- [128-Kbyte] 128-Kbyte cache capacity (One way: 32 Kbytes, the number of entries: H'07FF)
- [256-Kbyte] 256-Kbyte cache capacity (One way: 64 Kbytes, the number of entries: H'0FFF)
- [512-Kbyte] 512-Kbyte cache capacity (One way: 128 Kbytes, the number of entries: H'1FFF)
- [1-Mbyte] 1-Mbyte cache capacity (One way: 256 Kbytes, the number of entries: H'3FFF)

[Operand Cache]: Sets the capacity of the operand cache. Four ways, way 0 to way 3, are all valid, and the number of entry changes. (The number of entries in each way is the same.)

- [8-Kbyte] 8-Kbyte cache capacity (One way: 2 Kbytes, the number of entries: H'007F)
- [16-Kbyte] 16-Kbyte cache capacity (One way: 4 Kbytes, the number of entries: H'00FF)

[32-Kbyte]	32-Kbyte cache capacity (default) (One way: 8 Kbytes, the number of entries: H'01FF)
[64-Kbyte]	64-Kbyte cache capacity (One way: 16 Kbytes, the number of entries: H'03FF)
[128-Kbyte]	128-Kbyte cache capacity (One way: 32 Kbytes, the number of entries: H'07FF)
[256-Kbyte]	256-Kbyte cache capacity (One way: 64 Kbytes, the number of entries: H'0FFF)
[512-Kbyte]	512-Kbyte cache capacity (One way: 128 Kbytes, the number of entries: H'1FFF)
[1-Mbyte]	1-Mbyte cache capacity (One way: 256 Kbytes, the number of entries: H'3FFF)

Clicking the [OK] button modifies the cache capacity. Clicking the [Cancel] button closes the dialog box without modifying the cache capacity.

3.12.7 Saving the Currently Displayed Contents

The contents currently displayed in the window can be saved in a text file. Select [Save to File…] from the pop-up menu.

3.13 Viewing the Contents of Register Banks

The [Register Bank] window is used to view the contents of the register banks when using the SH2A-FPU simulator/debugger.

3.13.1 Opening the [Register Bank] Window

Choose [View -> CPU -> Register Bank] or click the [Register Bank] toolbar button to open the [Register Bank] window.

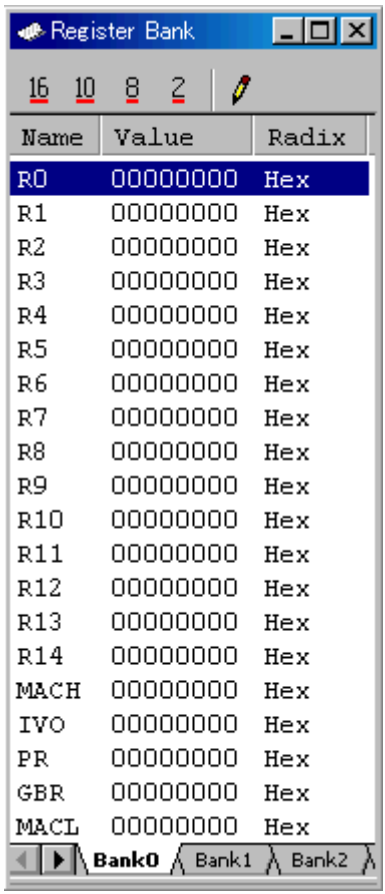


Figure 3.80 [Register Bank] Window

This window displays the register bank information. Since each bank has one sheet, clicking the bank's sheet displays the its contents. The contents of a currently disabled bank are grayed out.

The following items are displayed in the window:

[Name] Register name

[Value] Value

[Radix] Radix for display

3.13.2 Modifying the Contents of Register Banks

Selecting [Modify…] from the pop-up menu with a register bank item selected opens the dialog box to modify the selected register bank item.

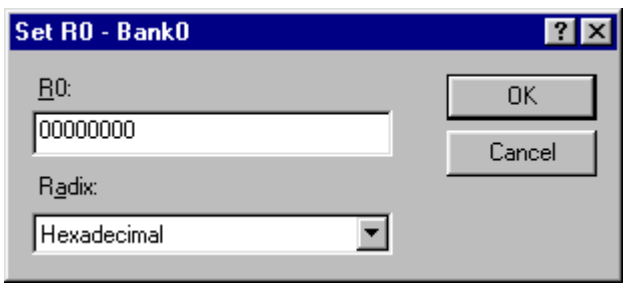


Figure 3.81 Register Value Setting Dialog Box

This dialog box allows the currently selected register bank item to be modified. The selected register bank item and bank number are displayed in the caption of the dialog box. The item name in the dialog box displays the selected register bank item.

Clicking the [OK] button stores the newly entered contents in the register bank. Clicking the [Cancel] button closes the dialog box without storing the newly entered contents.

A value can be directly input in the window.

3.13.3 Changing the Radix

To change the radix for display, select [Radix] from the pop-up menu with a register bank item selected.

3.14 Creating a Virtual I/O Panel

The simulator/debugger has a GUI I/O function for simulating a simple key-input or key-output panel of the user target system in a window. This virtual I/O panel is created in the [GUI I/O] window. That is, virtual buttons and virtual LEDs are arranged in this window to allow the input and output of data.

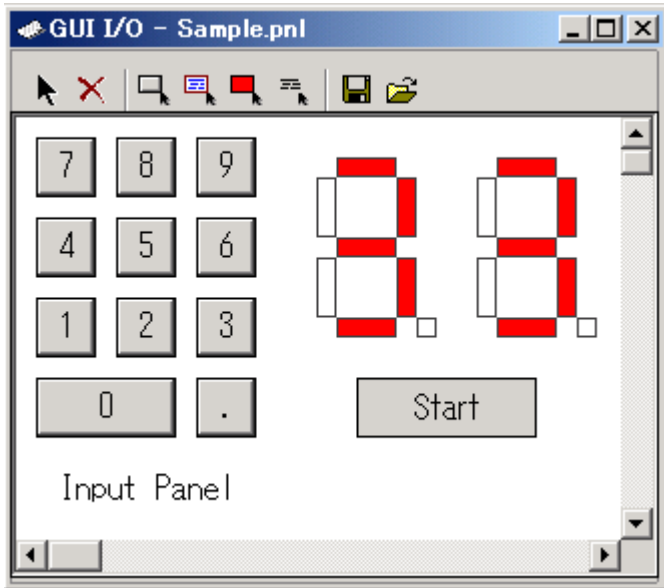


Figure 3.82 Example of a GUI I/O Window

3.14.1 Opening the [GUI I/O] Window

Choose [View -> Graphic -> GUI I/O] or click the [GUI I/O] toolbar button to open the [GUI I/O] window.

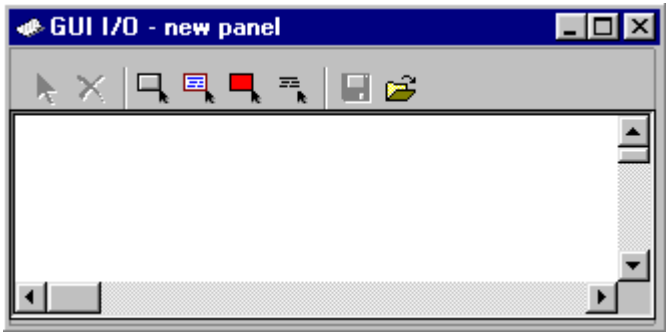


Figure 3.83 [GUI I/O] Window

This window is used to arrange the following items.

Button: Press a button for input of data to a virtual port or generation of a virtual interrupt.

Label: A character string which is shown when the value written to a selected address or bit was the specified value and hidden otherwise.

LED: A defined region in which a specified color is displayed (representing illumination of a LED) when the value written to a selected address or bit was the specified value.

Text: A region for the display of a text string.

3.14.2 Creating a Button

Click on the button of the toolbar or choose [Create Button] from the pop-up menu. The mouse cursor turns into a "+" symbol. Create the button by dragging the mouse cursor from a higher-left to a lower-right position.

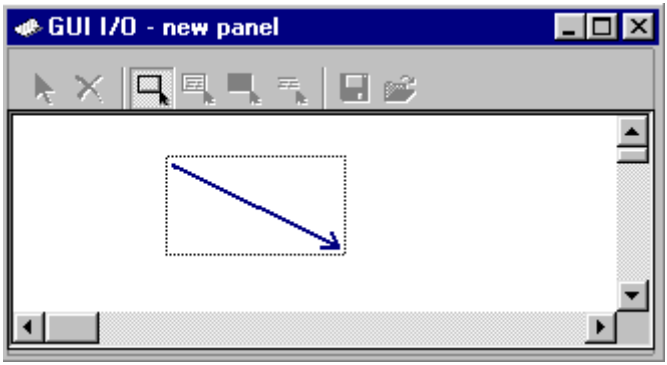


Figure 3.84 GUI I/O Window (Create Button)

- Specifying the event generated by clicking the button

Press the button on the toolbar and double-click on the created button to open the [Set Button] dialog box.

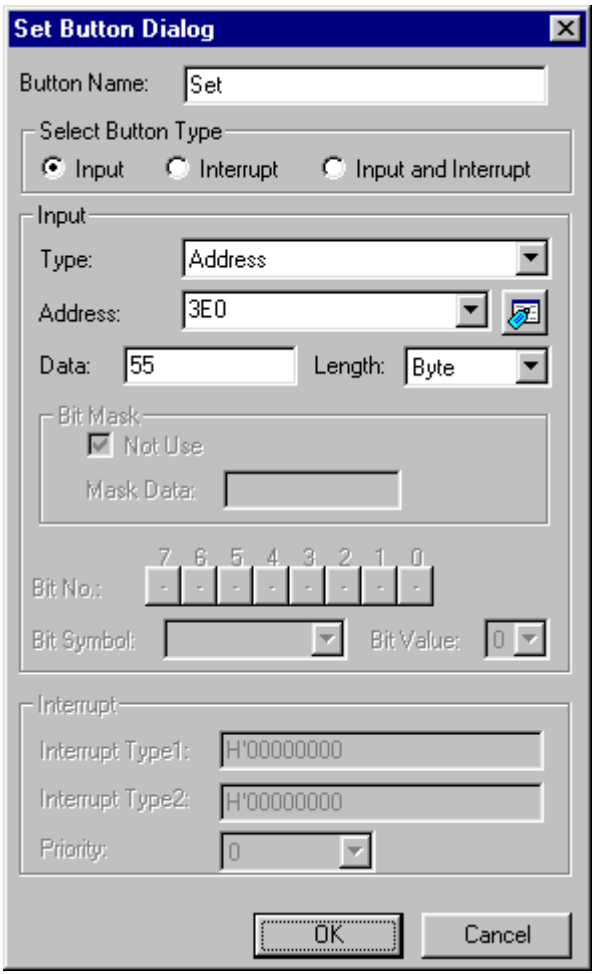


Figure 3.85 Set Button Dialog Box

Enter the name of the button, input port address, and input data. The button name must not include white space.

3.14.3 Creating a Label

Click on the button of the toolbar or choose [Create Label] from the pop-up menu. The mouse cursor turns into a "+" symbol. Drag the mouse cursor from a higher-left to a lower-right position. This shows the frame for the label.

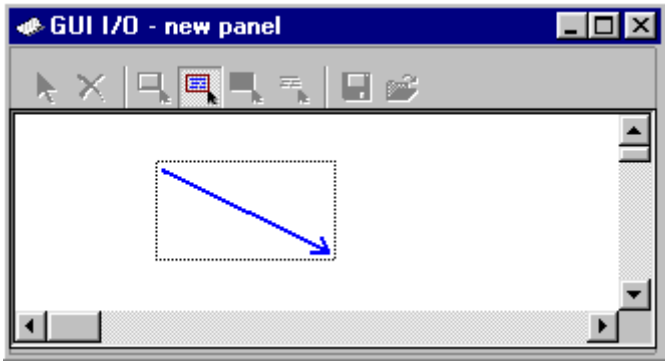


Figure 3.86 GUI I/O Window (Create Label)

Press the button on the toolbar or choose [Select Item] from the pop-up menu and double-click on the created label to open the [Set Label] dialog box. Specify the responses to events. The label name must not include white space.

- Response to writing of either value to a selected bit

The settings shown below set up display of the character string "Printing in progress" or "Printer ready" when the value of bit 3 at address 0x3E0 is 0 or 1, respectively.

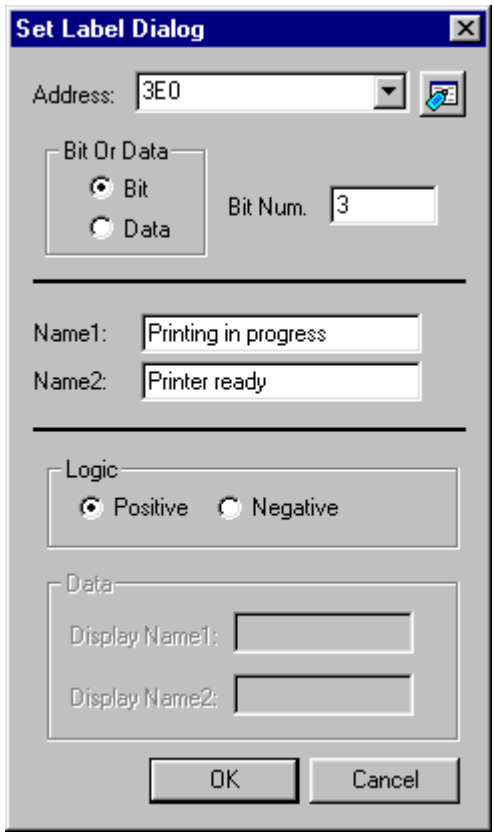


Figure 3.87 Set Label Dialog Box (Bit Selection)

- Response to writing of specified values to a selected address

The settings shown below set up display of the character string "Printing in progress" or "Printer ready" when the value 0x10 or 0x20, respectively, is written to address 0x3E0.

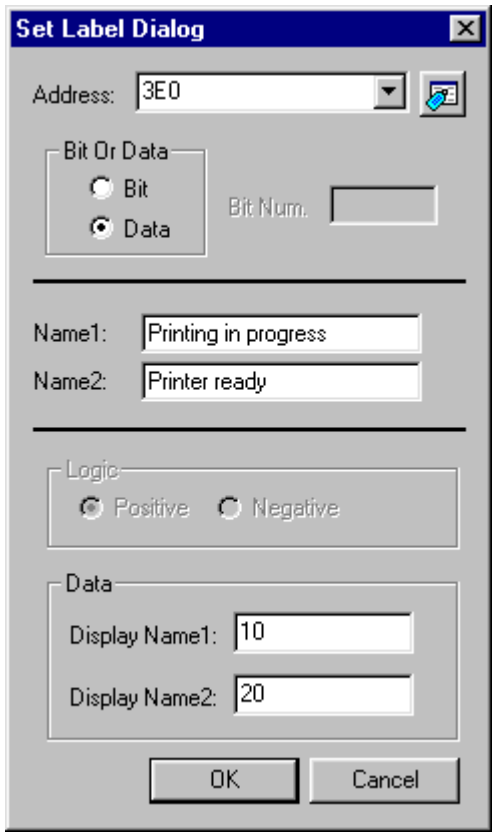


Figure 3.88 Set Label Dialog Box (Data Selection)

3.14.4 Creating an LED

Click on the button on the toolbar or choose [Create LED] from the pop-up menu. The mouse cursor turns into a "+" symbol. Drag the mouse cursor from an upper left to a lower right position. This shows the frame for the LED output.

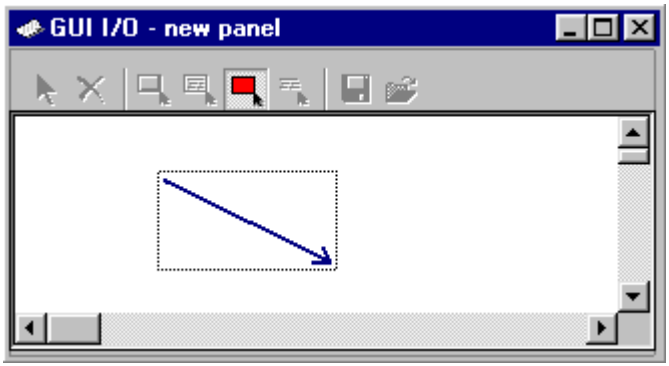


Figure 3.89 GUI I/O Window (Create LED)

Press the button on the toolbar or choose [Select Item] from the pop-up menu and double-click on the created LED to open the [Set LED] dialog box. Specify the events and responses.

- Response to writing of either value to a selected bit

The settings shown below set up the display of green or red, respectively, in the LED area when the value of bit 2 at address 0x3E0 is 0 or 1.

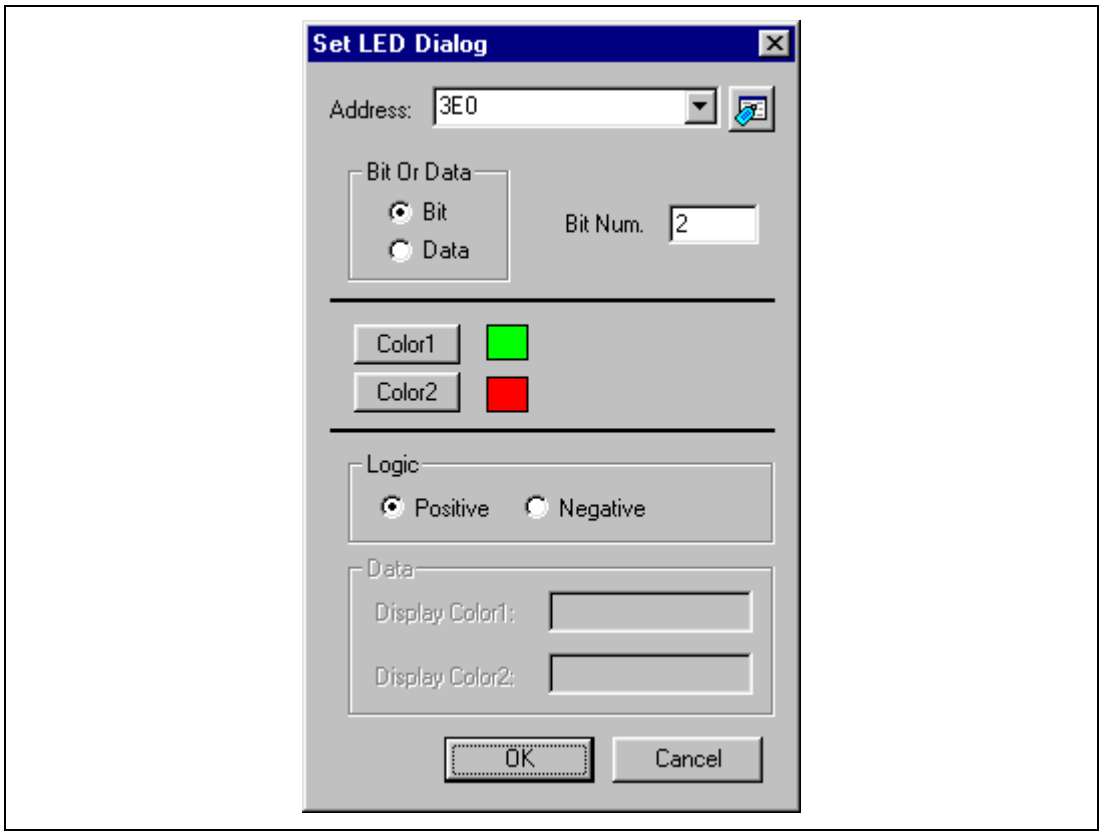


Figure 3.90 Set LED Dialog Box (Bit Selection)

- Response to writing of specified values to a selected address

The settings shown below set up the display of green or red, respectively, in the LED area when the value 0x10 or 0x20 is written to address 0x3E0.

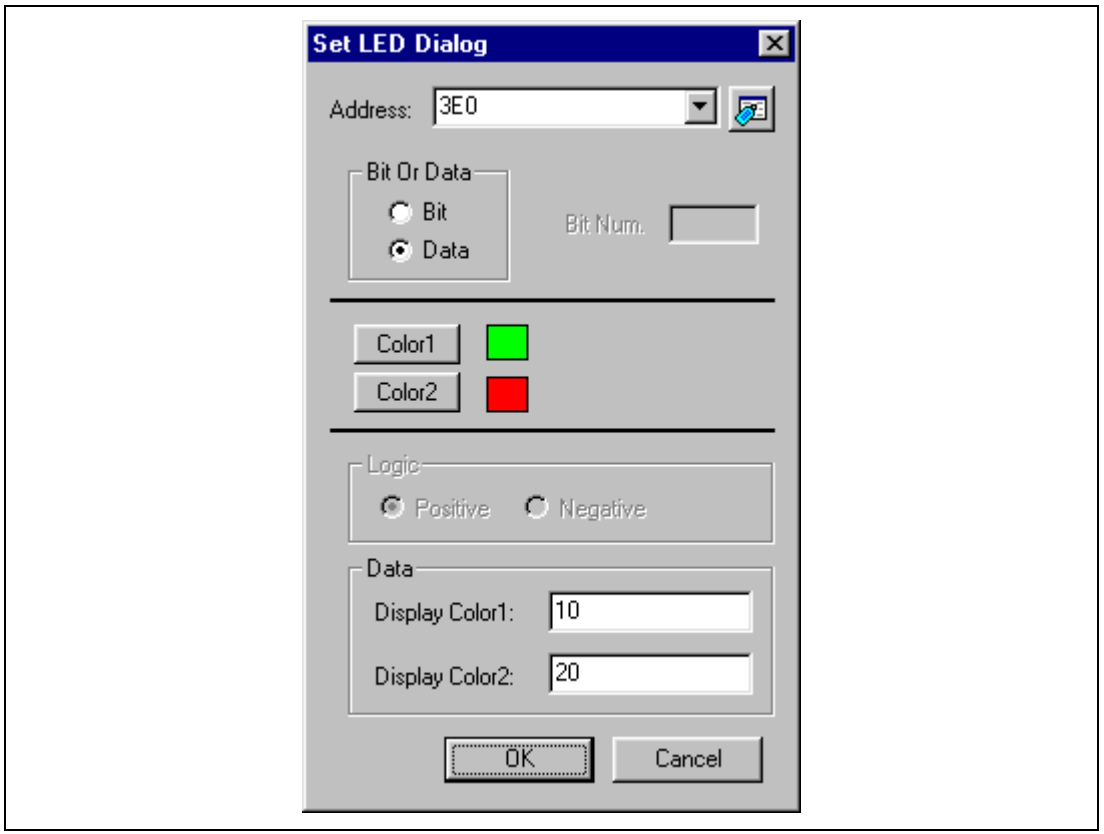


Figure 3.91 Set LED Dialog Box (Data Selection)

Clicking the [Color 1] or [Color 2] button opens the [Color] dialog box, which allows you to select the color.

3.14.5 Creating Fixed Text

Click the button on the toolbar or choose [Create Text] from the pop-up menu. The mouse cursor turns into a "+" symbol. Create the text box by dragging the mouse cursor from a higher-left to a lower-right position.

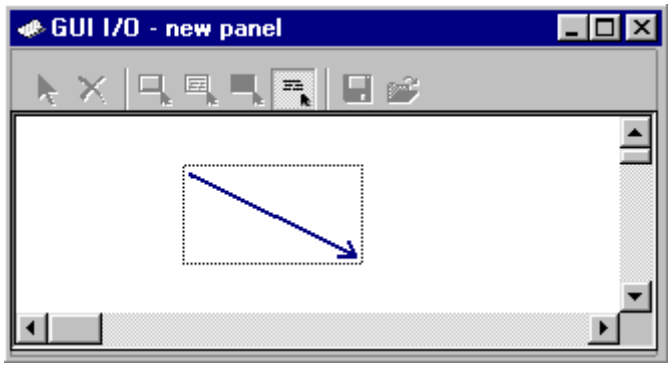


Figure 3.92 GUI I/O Window (Create Fixed Text)

- Setting the format for the text

Press the button on the toolbar and double-click on the created text to open the [Set Text] dialog box.

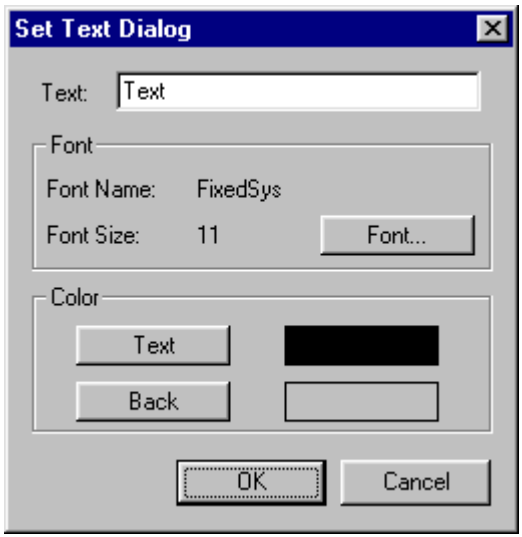


Figure 3.93 Set Text Dialog Box

Click the [Font…] button to select the font and size for the text. Then click the [Text] and [Back] buttons to specify the colors of the text and its background.

3.14.6 Changing the Size and Position of an Item

Press the button on the toolbar and click on the item. The item is selected as shown in the figure below.

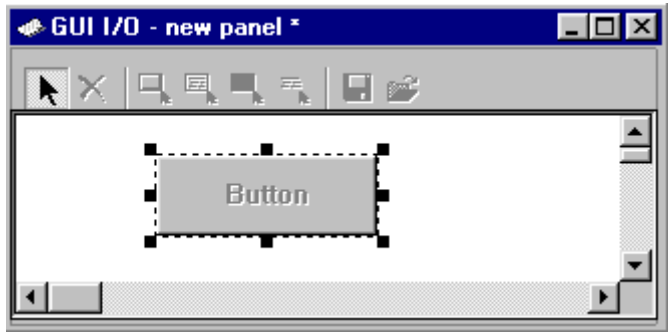


Figure 3.94 GUI I/O Window (Item Selected)

Drag the item to change its position or the control points to change its size.

3.14.7 Copying an Item

Press the button on the toolbar or choose [Copy] from the pop-up menu. The mouse cursor turns into a "+" symbol. In this state, click on the item you wish to copy. Press the button on the toolbar or choose [Paste] from the pop-up menu to create a new item with the same size and attributes.

3.14.8 Deleting an Item

Press the button on the toolbar or choose [Delete] from the pop-up menu. The mouse cursor turns into a "+" symbol. In this state, click on the item you wish to delete.

3.14.9 Showing the Grid

Press the button on the toolbar or choose [Display Grid] from the pop-up menu. This displays the grid on the background.

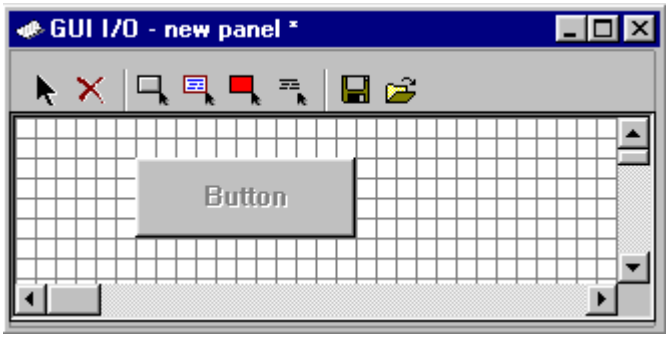


Figure 3.95 GUI I/O Window (Show Grid)

Clicking the button again hides the grid.

3.14.10 Saving I/O Panel Information

It is possible to reuse created I/O panels by saving the information in files. Press the button on the toolbar or choose [Save] from the pop-up menu to open the [Save GUI I/O Panel File] dialog box. Specify the directory where the file is to be stored and enter the file name.

3.14.11 Loading I/O Panel Information

Press the button on the toolbar or choose [Load] from the pop-up menu to open the [Load GUI I/O Panel File] dialog box. Specify the file you wish to load. Panel information prior to the load will be deleted.

Section 4 Windows

Table 4.1 lists the windows.

Refer to the simulator/debugger help about the toolbar buttons.

Table 4.1 Simulator/Debugger Windows

Window Name	Function
Cache	Viewing the cache contents
Command Line	Debugging with the Command Line Interface
Coverage	Acquiring Code Coverage
Disassembly	Viewing the Assembly-Language Code
Editor	Viewing a Program
Event	Using the Simulator/Debugger Breakpoints
GUI I/O	Creating a Virtual I/O Panel
Image	Displaying Memory Contents as an Image
IO	Viewing the I/O Memory
Label	Looking at Labels
Local	Looking at Variables (local variables)
Memory	Viewing a Memory Area
Profile/Profile-Chart	Viewing the Profile Information
Performance Analysis	Analyzing Performance
Register	Looking at Registers
Register Bank	Viewing the Contents of Register Banks
Simulated I/O	Standard I/O and File I/O Processing
Stack Trace	Viewing the Function Call History
Status	Viewing the Current Status
TLB	Viewing the TLB contents
Trace	Viewing the Trace Information
Trigger	Generating a Pseudo-Interrupt Manually
Watch	Looking at Variables (any variables)
Wave	Displaying Memory Contents as Waveforms

Section 5 Command Lines

5.1 Commands (Functional Order)

The following tables show the commands in functional order.

Refer to the help about each command.

5.1.1 Execution

Command Name	Abbreviation	Function
GO	GO	Executes user program
GO_RESET	GR	Executes user program from reset vector
GO_TILL	GT	Executes user program until temporary breakpoint
HALT	HA	Halts the user program
RESET	RE	Resets CPU
STEP	ST	Steps program (by instructions or source lines)
STEP_MODE	SM	Selects the step mode
STEP_OUT	SP	Steps out of the current function
STEP_OVER	SO	Steps program, not stepping into functions
STEP_RATE	SR	Sets or displays rate of stepping
STEP_UNIT	SN	Sets the unit of execution

5.1.2 Download

Command Name	Abbreviation	Function
BUILD	BU	Performs a build on the current project
BUILD_ALL	BL	Performs a build all on the current project
BUILD_FILE	BF	Compiles files
BUILD_MULTIPLE	BM	Builds multiple projects
CLEAN	CL	Deletes intermediate and output files produced in building
DEFAULT_OBJECT_FORMAT	DO	Sets the default object (program) format
FILE_LOAD	FL	Loads an object (program) file
FILE_LOAD_ALL	LA	Loads all object (program) files
FILE_SAVE	FS	Saves memory to a file
FILE_UNLOAD	FU	Unloads an object (program) file from memory
FILE_UNLOAD_ALL	UA	Unloads all object (program) files from memory
FILE_VERIFY	FV	Verifies file contents against memory
GENERATE_MAKE_FILE	GM	Generates a build makefile for the current workspace

5.1.3 Register

Command Name	Abbreviation	Function
REGISTER_ADDRESS_GET	RAG	Displays the address of the bank control register
REGISTER_ADDRESS_SET	RAS	Sets the address of the bank control register
REGISTER_DISPLAY	RD	Displays CPU register values
REGISTER_SET	RS	Changes CPU register contents

5.1.4 Register Bank (SH2A-FPU Only)

Command Name	Abbreviation	Function
REGISTER_BANK_ DISPLAY	RBD	Displays register bank values
REGISTER_BANK_SET	RBS	Changes the contents of register banks

5.1.5 Memory

Command Name	Abbreviation	Function
CACHE	-	Sets caching on or off
MEMORY_COMPARE	MC	Compares memory contents
MEMORY_DISPLAY	MD	Displays memory contents
MEMORY_EDIT	ME	Modifies memory contents
MEMORY_FILL	MF	Modifies the content of a memory area by specifying data
MEMORY_FIND	MI	Finds a string in an area of memory
MEMORY_MOVE	MV	Moves a block of memory
MEMORY_TEST	MT	Tests a block of memory

5.1.6 Assemble/Disassemble

Command Name	Abbreviation	Function
ASSEMBLE	AS	Assembles instructions into memory
DISASSEMBLE	DA	Disassembles memory contents
SYMBOL_ADD	SA	Defines a symbol
SYMBOL_CLEAR	SC	Deletes a symbol
SYMBOL_LOAD	SL	Loads a symbol information file
SYMBOL_SAVE	SS	Saves a symbol information file
SYMBOL_VIEW	SV	Displays symbols

5.1.7 Break

Command Name	Abbreviation	Function
BREAKPOINT	BP	Sets a breakpoint at an instruction address
BREAK_ACCESS	BA	Specifies a memory range access as a break condition
BREAK_CLEAR	BC	Deletes breakpoints
BREAK_CYCLE	BCY	Specifies a cycle as a break condition
BREAK_DATA	BD	Specifies a memory data value as a break condition
BREAK_DATA_ DIFFERENCE	BDD	Specifies a difference between two values of data in memory as a break condition
BREAK_DATA_ INVERSE	BDI	Specifies inversion of the sign of a value of data in memory as a break condition
BREAK_DISPLAY	BI	Displays a list of breakpoints
BREAK_ENABLE	BE	Enables or disables a breakpoint
BREAK_REGISTER	BR	Specifies a register data as a break condition
BREAK_SEQUENCE	BS	Sets sequential breakpoints
SET_DISASSEMBLY_ SOFT_BREAK	SDB	Sets or deletes a software breakpoint at the disassembly level
SET_SOURCE_ SOFT_BREAK	SSB	Sets or deletes a software breakpoint at the source level
STATE_ DISASSEMBLY_ SOFT_BREAK	TDB	Enables or disables a software breakpoint at the disassembly level
STATE_SOURCE_ SOFT_BREAK	TSB	Enables or disables a software breakpoint at the source level

5.1.8 Trace

Command Name	Abbreviation	Function
TRACE	TR	Displays trace information
TRACE_ACQUISITION	TA	Enables or disables trace information acquisition
TRACE_SAVE	TV	Outputs trace information into a file
TRACE_STATISTIC	TST	Analyzes statistic information

5.1.9 Coverage

Command Name	Abbreviation	Function
COVERAGE	CV	Enables or disables coverage measurement
COVERAGE_DISPLAY	CVD	Displays coverage information
COVERAGE_LOAD	CVL	Loads coverage information
COVERAGE_RANGE	CVR	Sets a coverage range
COVERAGE_SAVE	CVS	Saves coverage information

5.1.10 Performance

Command Name	Abbreviation	Function
ANALYSIS	AN	Enables or disables performance analysis
ANALYSIS_RANGE	AR	Sets or displays performance analysis functions
ANALYSIS_RANGE_DELETE	AD	Deletes a performance analysis range
PROFILE	PR	Enables or disables profile
PROFILE_DISPLAY	PD	Displays profile information
PROFILE_SAVE	PS	Saves the profile information to file

5.1.11 Watch

Command Name	Abbreviation	Function
WATCH_ADD	WA	Adds an item for watching
WATCH_AUTO_UPDATE	WU	Selects or cancels automatic updating of watched items
WATCH_DELETE	WD	Deletes a watched item
WATCH_DISPLAY	WI	Displays the contents of the Watch window
WATCH_EDIT	WE	Edits the value of a watched item
WATCH_EXPAND	WX	Expands or collapses a watched item
WATCH_RADIX	WR	Changes the radix for display of watched items
WATCH_RECORD	WO	Outputs the history of updating of the values of a watched item to a file
WATCH_SAVE	WS	Saves the contents of the Watch window to a file

5.1.12 Script/Logging

Command Name	Abbreviation	Function
!	-	Comment
ASSERT	-	Checks if an expression is true or false
AUTO_COMPLETE	AC	Enables or disables the auto-complete function
ERASE	ER	Clears the [Command Line] window
EVALUATE	EV	Evaluates an expression
LOG	LO	Controls command output logging
SLEEP	-	Delays command execution
SUBMIT	SU	Executes a command file
TCL	-	Displays TCL information

5.1.13 Memory Resource

Command Name	Abbreviation	Function
MAP_DISPLAY	MA	Displays memory resource settings
MAP_SET	MS	Allocates a memory area

5.1.14 Simulator/Debugger Settings

Command Name	Abbreviation	Function
CLOCK_RATE	CKR	Sets a clock rate
EXEC_MODE	EM	Sets and displays execution mode
EXEC_STOP_SET	ESS	Sets or displays the execution mode at the occurrence of an interrupt

5.1.15 Standard I/O and File I/O

Command Name	Abbreviation	Function
SIMULATEDIO_CLEAR	SIOC	Clears the contents of the [Simulated I/O] window
TRAP_ADDRESS	TP	Sets a simulated I/O address
TRAP_ADDRESS_DISPLAY	TD	Displays simulated I/O address settings
TRAP_ADDRESS_ENABLE	TE	Enables or disables the simulated I/O

5.1.16 Utility

Command Name	Abbreviation	Function
HELP	HE	Displays the command line help
INITIALIZE	IN	Initializes the debugging platform
QUIT	QU	Exits HEW
RADIX	RA	Sets default input radix
RESPONSE	RP	Sets an interval to refresh the window
STATUS	STA	Displays the debugging platform status
TOOL_INFORMATION	TO	Outputs information on the currently registered tool to a file

5.1.17 Project/Workspace

Command Name	Abbreviation	Function
ADD_FILE	AF	Adds a file to the current project
CHANGE_CONFIGURATION	CC	Sets the current configuration
CHANGE_PROJECT	CP	Sets the current project
CHANGE_SESSION	CS	Changes the current session
CHANGE_SUB_SESSION	CB	Changes the currently active session when simultaneous debugging is enabled
CLEAR_OUTPUT_WINDOW	COW	Clears the contents of the specified tab in the [Output] window
CLOSE_WORKSPACE	CW	Close the current workspace
OPEN_WORKSPACE	OW	Opens a workspace
REFRESH_SESSION	RSE	Updates information on the session
REMOVE_FILE	REM	Removes a file from the current project
SAVE_SESSION	SE	Saves the current session
SAVE_WORKSPACE	SW	Saves the current workspace
UPDATE_ALL_DEPENDENCIES	UD	Updates all build dependencies of the current project

5.1.18 Test Tool Facility

Command Name	Abbreviation	Function
CLOSE_TEST_SUITE	CTS	Closes a test suite
COMPARE_TEST_DATA	CTD	Compares test data
OPEN_TEST_SUITE	OTS	Opens a test suite
RUN_TEST	RT	Executes a test

5.2 Commands (Alphabetical Order)

Table 5.1 lists the commands in alphabetical order.

Refer to the help about each command.

Table 5.1 Simulator/Debugger Commands

No.	Command Name	Abbreviation	Function
1	!	-	Comment
2	ADD_FILE	AF	Adds a file to the current project
3	ANALYSIS	AN	Enables or disables performance analysis
4	ANALYSIS_RANGE	AR	Sets or displays performance analysis functions
5	ANALYSIS_RANGE_ DELETE	AD	Deletes a performance analysis range
6	ASSEMBLE	AS	Assembles instructions into memory
7	ASSERT	-	Checks if an expression is true or false
8	AUTO_COMPLETE	AC	Enables or disables the auto-complete function
9	BREAKPOINT	BP	Sets a breakpoint at an instruction address
10	BREAK_ACCESS	BA	Specifies a memory range access as a break condition
11	BREAK_CLEAR	BC	Deletes breakpoints
12	BREAK_CYCLE	BCY	Specifies a cycle as a break condition
13	BREAK_DATA	BD	Specifies a memory data value as a break condition
14	BREAK_DATA_ DIFFERENCE	BDD	Specifies a difference between two values of data in memory as a break condition
15	BREAK_DATA_ INVERSE	BDI	Specifies inversion of the sign of a value of data in memory as a break condition
16	BREAK_DISPLAY	BI	Displays a list of breakpoints
17	BREAK_ENABLE	BE	Enables or disables a breakpoint
18	BREAK_REGISTER	BR	Specifies a register data as a break condition
19	BREAK_SEQUENCE	BS	Sets sequential breakpoints
20	BUILD	BU	Performs a build on the current project
21	BUILD_ALL	BL	Performs a build all on the current project
22	BUILD_FILE	BF	Compiles files
23	BUILD_MULTIPLE	BM	Builds multiple projects

Table 5.1 Simulator/Debugger Commands (cont)

No.	Command Name	Abbreviation	Function
24	CACHE	-	Sets caching on or off
25	CHANGE_ CONFIGURATION	CC	Sets the current configuration
26	CHANGE_PROJECT	CP	Sets the current project
27	CHANGE_SESSION	CS	Changes the current session
28	CHANGE_SUB_ SESSION	CB	Changes the currently active session when simultaneous debugging is enabled
29	CLEAN	CL	Deletes intermediate and output files produced in building
30	CLEAR_OUTPUT_ WINDOW	COW	Clears the contents of the specified tab in the [Output] window
31	CLOCK_RATE	CKR	Sets a clock rate
32	CLOSE_TEST_SUITE	CTS	Closes a test suite
33	CLOSE_WORKSPACE	CW	Close the current workspace
34	COMPARE_TEST_ DATA	CTD	Compares test data
35	COVERAGE	CV	Enables or disables coverage measurement
36	COVERAGE_DISPLAY	CVD	Displays coverage information
37	COVERAGE_LOAD	CVL	Loads coverage information
38	COVERAGE_RANGE	CVR	Sets a coverage range
39	COVERAGE_SAVE	CVS	Saves coverage information
40	DEFAULT_OBJECT_ FORMAT	DO	Sets the default object (program) format
41	DISASSEMBLE	DA	Disassembles memory contents
42	ERASE	ER	Clears the [Command Line] window
43	EVALUATE	EV	Evaluates an expression
44	EXEC_MODE	EM	Sets and displays execution mode
45	EXEC_STOP_SET	ESS	Sets or displays the execution mode at the occurrence of an interrupt
46	FILE_LOAD	FL	Loads an object (program) file
47	FILE_LOAD_ALL	LA	Loads all object (program) files
48	FILE_SAVE	FS	Saves memory to a file

Table 5.1 Simulator/Debugger Commands (cont)

No.	Command Name	Abbreviation	Function
49	FILE_UNLOAD	FU	Unloads an object (program) file from memory
50	FILE_UNLOAD_ALL	UA	Unloads all object (program) files from memory
51	FILE_VERIFY	FV	Verifies file contents against memory
52	GENERATE_MAKE_FILE	GM	Generates a build makefile for the current workspace
53	GO	GO	Executes user program
54	GO_RESET	GR	Executes user program from reset vector
55	GO_TILL	GT	Executes user program until temporary breakpoint
56	HALT	HA	Halts the user program
57	HELP	HE	Displays the command line help
58	INITIALIZE	IN	Initializes the debugging platform
59	LOG	LO	Controls command output logging
60	MAP_DISPLAY	MA	Displays memory resource settings
61	MAP_SET	MS	Allocates a memory area
62	MEMORY_COMPARE	MC	Compares memory contents
63	MEMORY_DISPLAY	MD	Displays memory contents
64	MEMORY_EDIT	ME	Modifies memory contents
65	MEMORY_FILL	MF	Modifies the content of a memory area by specifying data
66	MEMORY_FIND	MI	Finds a string in an area of memory
67	MEMORY_MOVE	MV	Moves a block of memory
68	MEMORY_TEST	MT	Tests a block of memory
69	OPEN_TEST_SUITE	OTS	Opens a test suite
70	OPEN_WORKSPACE	OW	Opens a workspace
71	PROFILE	PR	Enables or disables profile
72	PROFILE_DISPLAY	PD	Displays profile information
73	PROFILE_SAVE	PS	Saves the profile information to file
74	QUIT	QU	Exits HEW
75	RADIX	RA	Sets default input radix
76	REFRESH_SESSION	RSE	Updates information on the session

Table 5.1 Simulator/Debugger Commands (cont)

No.	Command Name	Abbreviation	Function
77	REGISTER_ADDRESS_ GET	RAG	Displays the address of bank control registers
78	REGISTER_ADDRESS_ SET	RAS	Sets the address of bank control registers
79	REGISTER_DISPLAY	RD	Displays CPU register values
80	REGISTER_SET	RS	Changes CPU register contents
81	REGISTER_BANK_ DISPLAY	RBD	Displays register bank values
82	REGISTER_BANK_SET	RBS	Changes the contents of register banks
83	REMOVE_FILE	REM	Removes a file from the current project
84	RESET	RE	Resets CPU
85	RESPONSE	RP	Sets an interval to refresh the window
86	RUN_TEST	RT	Executes a test
87	SLEEP	-	Delays command execution
88	SAVE_SESSION	SE	Saves the current session
89	SAVE_WORKSPACE	SW	Saves the current workspace
90	SET_DISASSEMBLY_ SOFT_BREAK	SDB	Sets or deletes a software breakpoint at the disassembly level
91	SET_SOURCE_ SOFT_BREAK	SSB	Sets or deletes a software breakpoint at the source level
92	SIMULATEDIO_CLEAR	SIOC	Clears the contents of the [Simulated I/O] window
93	STATE_DISASSEMBLY_ SOFT_BREAK	TDB	Enables or disables a software breakpoint at the disassembly level
94	STATE_SOURCE_ SOFT_BREAK	TSB	Enables or disables a software breakpoint at the source level
95	STATUS	STA	Displays the debugging platform status
96	STEP	ST	Steps program (by instructions or source lines)
97	STEP_MODE	SM	Selects the step mode
98	STEP_OUT	SP	Steps out of the current function
99	STEP_OVER	SO	Steps program, not stepping into functions
100	STEP_RATE	SR	Sets or displays rate of stepping
101	STEP_UNIT	SN	Sets the unit of execution

Table 5.1 Simulator/Debugger Commands (cont)

No.	Command Name	Abbreviation	Function
102	SUBMIT	SU	Executes a command file
103	SYMBOL_ADD	SA	Defines a symbol
104	SYMBOL_CLEAR	SC	Deletes a symbol
105	SYMBOL_LOAD	SL	Loads a symbol information file
106	SYMBOL_SAVE	SS	Saves a symbol information file
107	SYMBOL_VIEW	SV	Displays symbols
108	TCL	-	Enables or disables the TCL
109	TOOL_INFORMATION	TO	Outputs information on the currently registered tool to a file
110	TRACE	TR	Displays trace information
111	TRACE_ACQUISITION	TA	Enables or disables trace information acquisition
112	TRACE_SAVE	TV	Outputs trace information into a file
113	TRACE_STATISTIC	TST	Analyzes statistic information
114	TRAP_ADDRESS	TP	Sets a simulated I/O address
115	TRAP_ADDRESS_ DISPLAY	TD	Displays simulated I/O address settings
116	TRAP_ADDRESS_ ENABLE	TE	Enables or disables the simulated I/O
117	UPDATE_ALL_ DEPENDENCIES	UD	Updates all build dependencies of the current project
118	WATCH_ADD	WA	Adds an item for watching
119	WATCH_AUTO_ UPDATE	WU	Selects or cancels automatic updating of watched items
120	WATCH_DELETE	WD	Deletes a watched item
121	WATCH_DISPLAY	WI	Displays the contents of the Watch window
122	WATCH_EDIT	WE	Edits the value of a watched item
123	WATCH_EXPAND	WX	Expands or collapses a watched item
124	WATCH_RADIX	WR	Changes the radix for display of watched items
125	WATCH_RECORD	WO	Outputs the history of updating of the values of a watched item to a file
126	WATCH_SAVE	WS	Saves the contents of the Watch window to a file

Section 6 Messages

6.1 Information Messages

The simulator/debugger outputs information messages as listed in table 6.1 to notify users of execution status.

Table 6.1 Information Messages

Message	Contents
Break Access (Access Address: H'nnnnnnnn, Type: xxxx, Access Size: yyyy)	An access break condition was satisfied so execution has stopped. The information in parentheses shows the satisfied access break condition (accessed address, access type, and access unit).
Break Cycle (Cycle: H'nnnnnnnn)	A number-of-cycles condition was satisfied so execution has stopped. The information in parentheses shows the satisfied number-of-cycles condition (number of cycles).
Break Data (Access Address: H'nnnnnnnn, Data: H'mmmmmmmm)	A data break condition ([Equal] or [Not equal]) was satisfied so execution has stopped. The information in parentheses shows the satisfied data break condition (accessed address and value).
Break Data (Access Address: H'nnnnnnnn, Previous Data: H'mmmmmmmm, Current Data: H'mmmmmmmm)	A data break condition ([Inverse sign] or [Difference]) was satisfied so execution has stopped. The information in parentheses shows the satisfied data break condition (accessed address, and previous and current values).
Break Register (Register: XX, Value: H'mmmmmmmm)	A register break condition was satisfied so execution has stopped. The information in parentheses shows the satisfied register break condition (register name and value).
Break Sequence (PC: H'nnnnnnnn)	A sequential break condition was satisfied so execution has stopped. The information in parentheses shows the satisfied sequential break condition (address of the last instruction).
I/O DLL Stop	The peripheral function has stopped.
PC Breakpoint (PC: H'nnnnnnnn)	A PC breakpoint condition was satisfied so execution has stopped. The information in parentheses shows the satisfied PC-breakpoint condition (instruction address).
Sleep	Execution has been stopped by the SLEEP instruction.
Step Normal End	The step execution succeeded.

Table 6.1 Information Messages (cont)

Message	Contents
Stop	Execution has been stopped by the [Stop] button.
Trace Buffer Full	Since the Break mode was selected by [Trace buffer full handling] in the [Trace Acquisition] dialog box and the trace buffer became full, execution was terminated.

6.2 Error Messages

The simulator/debugger outputs error messages to notify users of the errors of user programs or operation. Table 6.2 lists the error messages.

Table 6.2 Error Messages

Message	Contents
Address Error	One of the following states occurred: • The PC value was an odd number. • An instruction was read from the internal I/O area. • Word data was accessed to an address that was not a multiple of 2. • Longword data was accessed to an address that was not a multiple of 4. • The VBR or SP value was not a multiple of 4. • An error occurred in the exception processing of an address error. Correct the user program to prevent the error.
Exception Error	An error occurred during exception processing. Correct the user program to prevent the error.
File Open Error	An error occurred during opening a file with the file-input/output action of Break. Correct the file setting.
File Input Error	An error occurred during reading a file with file-input/output action of Break. Correct the file setting.
File Output Error	An error occurred during writing to a file with file-input/output action of Break. Correct the file setting.
FPU Disable	An attempt was made to execute an FPU instruction while the FPU is disabled (SR.FD = 1). Correct the user program to prevent the error.

Table 6.2 Error Messages (cont)

Message	Contents
FPU Error	One of the following states occurred during floating-point operation: • An FPU error • An invalid operation • A division by zero • An overflow • An underflow • An inaccurate operation Correct the user program to prevent the error.
General Invalid Instruction	Either of the following states occurred: • A code other than an instruction was executed. • An error occurred in the exception processing of a reserved instruction exception. Correct the user program to prevent the error.
Illegal CCR2 Set	The CCR2 value is illegal. Check the setting.
Illegal Combination BSC Register	An attempt was made to access the area for which the BSC register setting was invalid. Correct the user program to prevent the error.
Illegal DSP Operation	Either of the following states occurred: • A shift of more than 32 bits was executed with the PSHA instruction. • A shift of more than 16 bits was executed with the PSHL instruction. Correct the user program to prevent the error.
Illegal LRU Set	The LRU value of the cache is invalid. Check the setting.
Illegal Operation	Either of the following states occurred: • A division by zero occurred during DIV1 instruction execution. • Zero was written to by the SETRC instruction. Correct the user program to prevent the error.
Illegal PR bit	An attempt was made to execute an FPU instruction while the PR bit value of the FPSCR is illegal. Correct the user program to prevent the error.
Initial Page Write	An initial page write exception occurred during simulation. Take necessary procedures such as updating the TLB contents.
Instruction TLB Illegal LRU	The LRU value in the instruction TLB is illegal. Check the setting.

Table 6.2 Error Messages (cont)

Message	Contents
Instruction TLB Miss	An instruction TLB miss occurred during memory access. Take necessary procedures such as updating the instruction TLB contents.
Instruction TLB Multiple Hit	Multiple instruction TLB entries were hit when a virtual address was accessed during simulation or command execution. The instruction TLB is not correctly set. Modify instruction TLB contents and user program (handler routine).
Instruction TLB Protection Violation	An instruction TLB protection exception occurred during memory access. Take necessary procedures such as updating the instruction TLB contents.
Interrupt Exception	An interrupt exception occurred, execution halted.
Invalid DSP Instruction Code	An invalid instruction code was detected in the DSP parallel instruction. Correct the user program to prevent the error.
Invalid Slot Instruction	Either of the following states occurred: • An instruction that changes the PC value (a branch instruction) immediately after a delayed branch instruction was executed. • An error occurred during the exception processing of an invalid slot instruction. Correct the user program to prevent the error.
Invalid Register Bank Number	A bank or entry that does not exist was specified in a STBANK or LDBANK instruction. Specify a correct bank or entry.
I/O area not exist	An attempt was made to delete the I/O area. Be sure to set the I/O area.
I/O DLL Illegal Interrupt Information (errNum=2xx)	Information on interrupts is incorrect. [errNum] shows the details on this error. Correct the information. [errNum] 200: The specified vector is outside the supported range. 201: The specified priority is outside the supported range.
I/O DLL Memory Access Error (errNum=0xx, Address=0xXXXXXXXX)	An error has occurred during a memory access to the peripheral function. [errNum] shows the details on this error and [Address] shows the address where this error occurred. Correct the user program according to the error information. [errNum] 001: The specified address is outside the supported range. 002: No memory exists in the specified area. 003: The required memory cannot be allocated. 004: The specified data size is outside the supported range. 005: The specified address cannot be accessed.

Table 6.2 Error Messages (cont)

Message	Contents
I/O DLL Register Access Error (errNum=1xx, RegisterName=xxxx)	An error has occurred during a register access to the peripheral function. [errNum] shows the details on this error and [RegisterName] shows the register where this error occurred. Correct the user program according to the error information. [errNum] 100: The register description is incorrect. 101: The specified data value is incorrect.
Memory Access Error (Address: H'nnnnnnnn)	One of the following events occurred (the information in parentheses shows the target address for the operation that generated the error): • A memory area that had not been allocated was accessed. • Data was written to a memory area having the write-protected attribute. • Data was read from a memory area having the read-disabled attribute. • A memory area in which memory does not exist was accessed. Allocate memory, change the memory attribute, or correct the user program to prevent the memory from being accessed.
Multiple Exception	Multiple exceptions occurred. Correct the user program to prevent the error.
PMB Multiple Hit	Multiple PMB entries were hit when a virtual address was accessed during simulation or command execution. PMB is not correctly set. Modify PMB contents and user program (handler routine).
PMB Miss	PMB miss occurred during simulation or command execution. Take necessary procedures such as updating the PMB contents.
Register Bank Overflow	An interrupt that uses register banks was generated after acceptance of register bank overflows had been selected and data had been saved in all register banks.
Register Bank Underflow	A RESBANK instruction was executed when no data had been saved in the register banks.
Slot FPU Disable	An attempt was made to execute an FPU instruction in a delay slot while the FPU is disabled (SR.FD = 1). Correct the user program to prevent the error.
System Call Error	Simulated I/O error occurred. Modify the incorrect contents of registers R0, R1, and parameter block.

Table 6.2 Error Messages (cont)

Message	Contents
The memory resource has not been set up	The memory resource was set outside the range of memory mapping. Modify the memory resource settings so that no error will occur.
TLB Invalid	TLB invalid exception occurred during simulation or command execution. Take necessary procedures such as updating the TLB contents.
TLB Miss	TLB miss occurred during simulation or command execution. Take necessary procedures such as updating the TLB contents.
TLB Multiple Hit	Multiple TLB entries were hit when a virtual address was accessed during simulation or command execution. TLB is not correctly set. Modify TLB contents and user program (handler routine).
TLB Protection Violation	Illegal TLB protection exception occurred during simulation. Take necessary procedures such as updating the TLB contents.
Unified TLB Miss	A unified TLB miss occurred during memory access. Take necessary procedures such as updating the unified TLB contents.
Unified TLB Multiple Hit	Multiple unified TLB entries were hit when a virtual address was accessed during simulation or command execution. The unified TLB is not correctly set. Modify the unified TLB contents and user program (handler routine).
Unified TLB Protection Violation	A unified TLB protection exception occurred during memory access. Take necessary procedures such as updating the unified TLB contents.

Section 7 Tutorial

7.1 Preparation

The basic functions of the simulator/debugger will be described in this section using a sample program.

Note: The contents of usage examples (figures) in this section will differ depending on the compiler version.

7.1.1 Sample Program

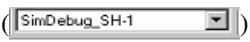
The HEW demonstration program is used for the sample program and is written in C language. It first sorts ten random data in the ascending order, and then in the descending order. The sample program:

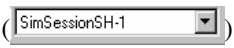
(1) Generates random data for sorting using the main function.
(2) Inputs the array which stores the random data that is generated by the main function, then sorts the data in the ascending order using the sort function.
(3) Inputs the array generated by the sort function, and sorts the data in the descending order using the change function.
(4) Displays the random data and the sorted data using the printf function.

The HEW demonstration program is used as the sample program.

7.1.2 Creating the Sample Program

Note the following when creating the HEW demonstration program:

- Specify [Demonstration] for [Project Type] in [Creating a New Workspace].
- Specify [SH-1] for [CPU Series:].
- Specify [SH-1 Simulator] for [Target:].
- Specify [SimDebug_SH-1] (

) for the configuration on the toolbar before building the project.
- Specify [SimSession_SH-1] (

) for the session on the toolbar.
- This demonstration program uses no peripheral function (timer). In the [Set Peripheral Function Simulation] dialog box that opens when the session is changed, check [Don't show this dialog box] and then press the [OK] button.

Since this section explains the debugging function, [Demonstration] has not been optimized. Do not change this setting.

7.2 Settings for Debugging

7.2.1 Allocating the Memory Resource

The allocation of the memory resource is necessary to run the application being developed. When using the demonstration project, the memory resource is allocated automatically, so check the setting.

- Select [Simulator->Memory Resource...] from the [Setup] menu, and display the allocation of the current memory resource.

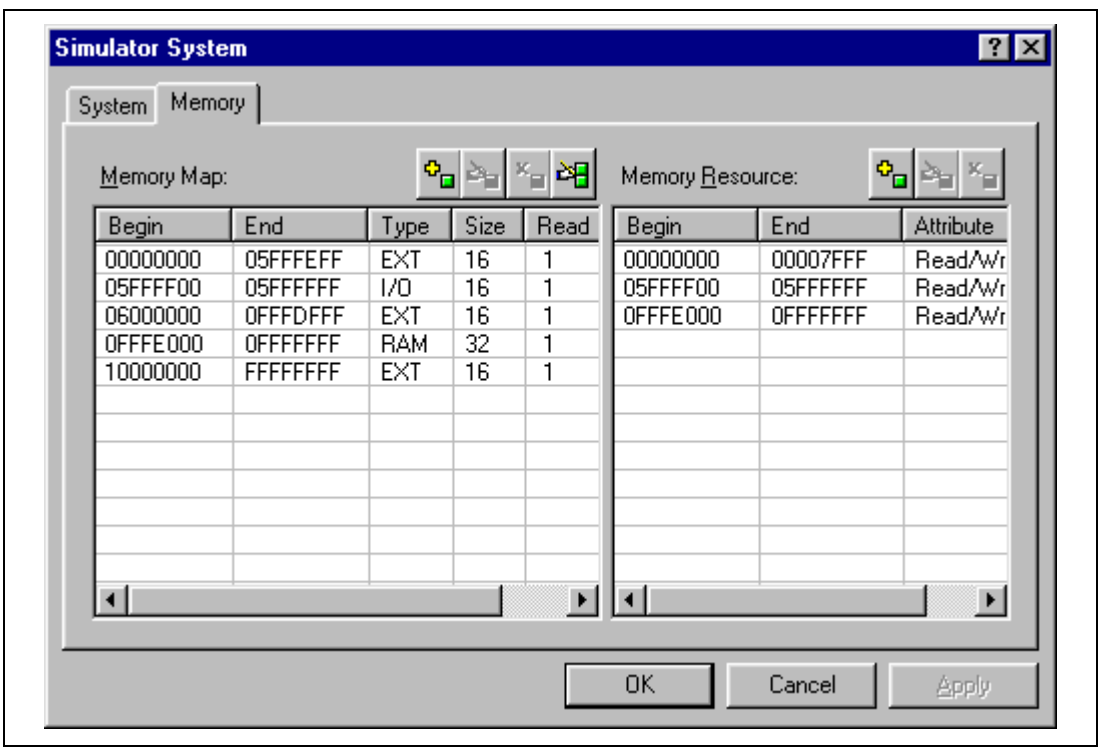


Figure 7.1 Simulator System Dialog Box (Memory Page)

The program area is allocated to the range of the addresses H'00000000 to H'00007FFF. The stack area is allocated to the range of the addresses H'0FFFE000 to H'0FFFFFFF, which can be read from or written to.

- Close the dialog box by clicking [OK].

The memory resource can also be referred to or modified by using the [Debugger] page on the [SuperH RISC engine Standard Toolchain] dialog box. Changes made in either of the dialog boxes are reflected.

7.2.2 Downloading the Sample Program

When using the demonstration project, the sample program to be downloaded is automatically set, so check the settings.

- Open the [Debug Setting] dialog box by selecting [Debug Settings...] on the [Debug] menu.

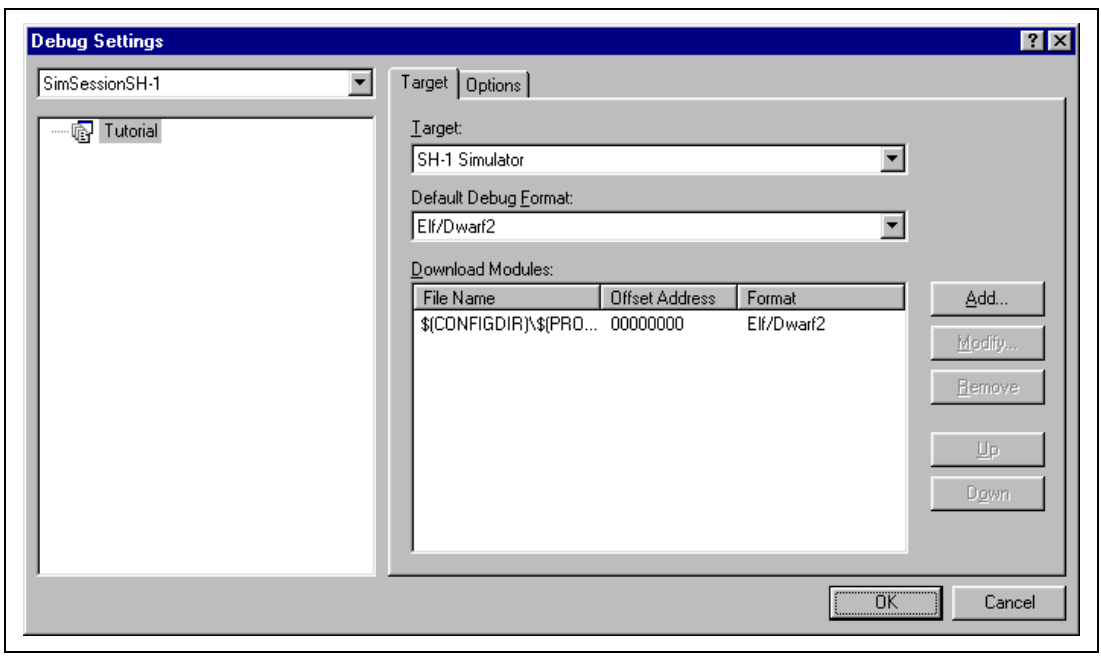


Figure 7.2 Debug Settings Dialog Box

- Files to be downloaded are listed in [Download Modules].
- Close the [Debug Settings] dialog box by clicking the [OK] button.

- Download the sample program by selecting [Download Modules->All Download Modules] from the [Debug] menu.

7.2.3 Displaying the Source Program

The HEW supports source-level debugging. Display the source file ("Tutorial.c") in the [Source] window.

- Open the [Source] window by double-clicking Tutorial.c on the [Workspace] window.

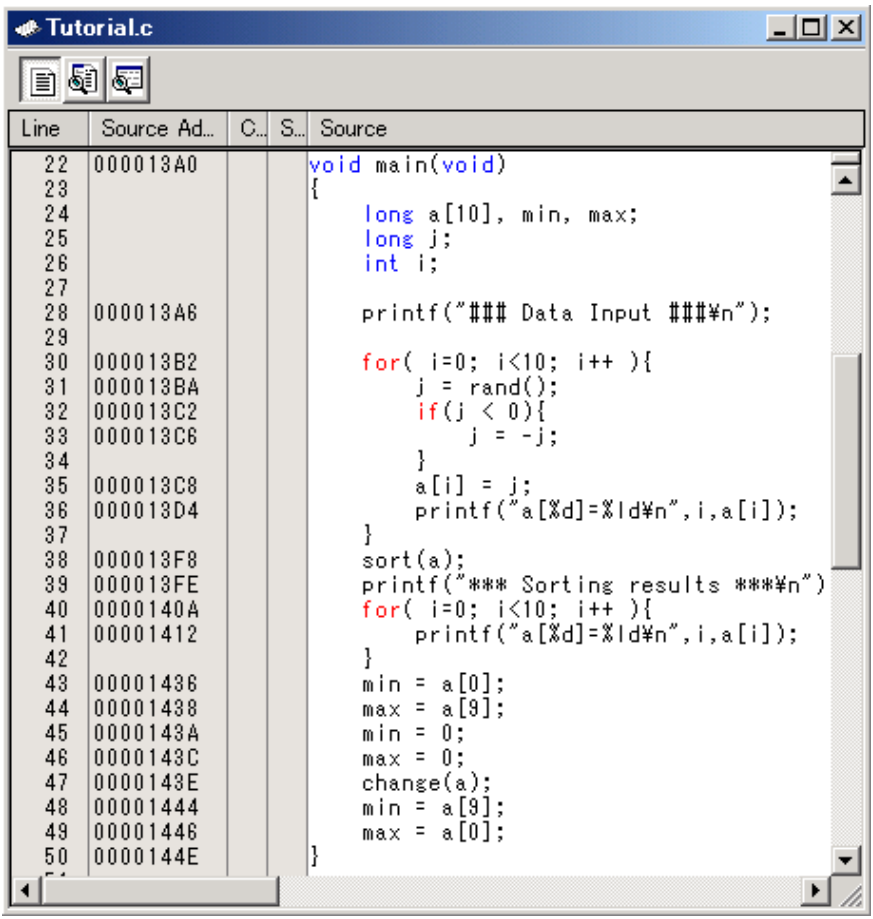


Figure 7.3 Source Window (Displaying the Source Program)

7.2.4 Setting a PC Breakpoint

Breakpoints can be set easily via the [Source] window. To set a breakpoint on a line that includes the sort function call:

- Place the cursor in the line that includes the sort function call and click the right mouse button to launch the pop-up menu, and select [Toggle Breakpoint] from the pop-up menu.

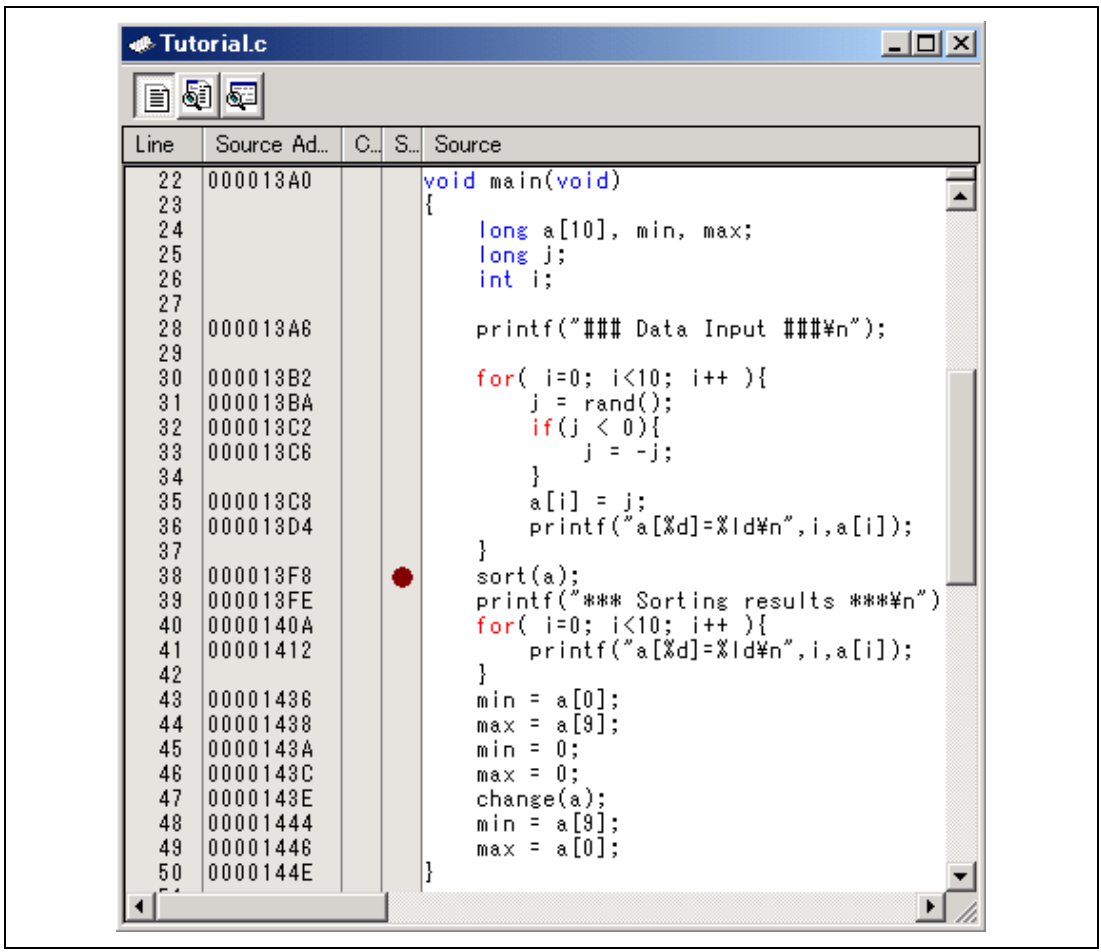


Figure 7.4 Source Window (Setting the Breakpoint)

A [•] is displayed at the line that includes the sort function call, indicating that the PC breakpoint is set at the address.

7.2.5 Setting the Profiler

- Open the [Profile] window by selecting [Profile] from the [View->Performance] menu.

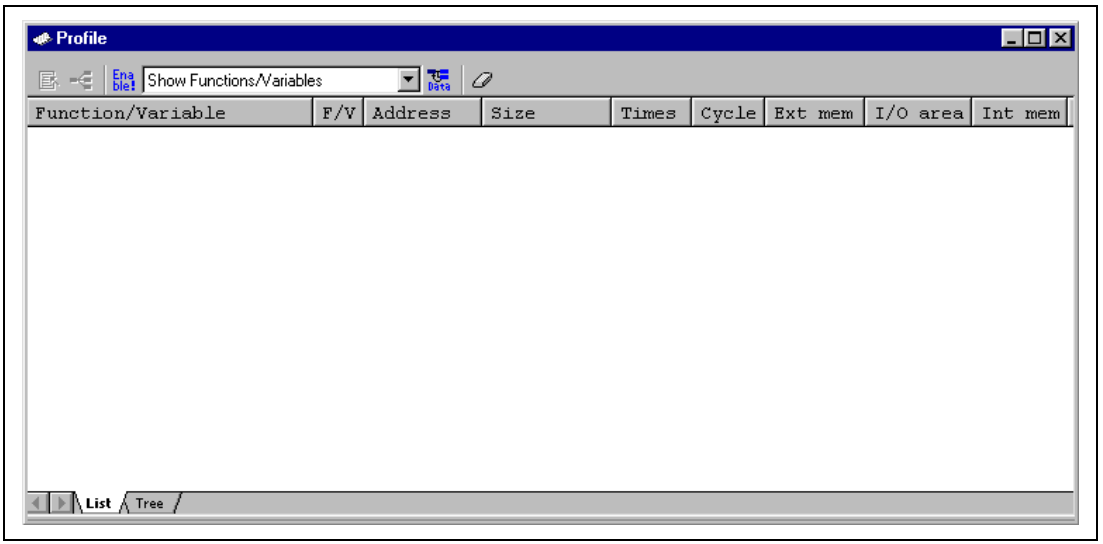


Figure 7.5 Profile Window

- Open the pop-up menu by right clicking the mouse on the [Profile] window, and select [Enable Profiler] to enable acquisition of the profile information.

7.2.6 Setting the Simulated I/O

When the demonstration project is used, the simulated I/O is automatically set, so check the setting.

- Open the [Simulator System] dialog box by selecting [Simulator->System] from the [Setup] menu.

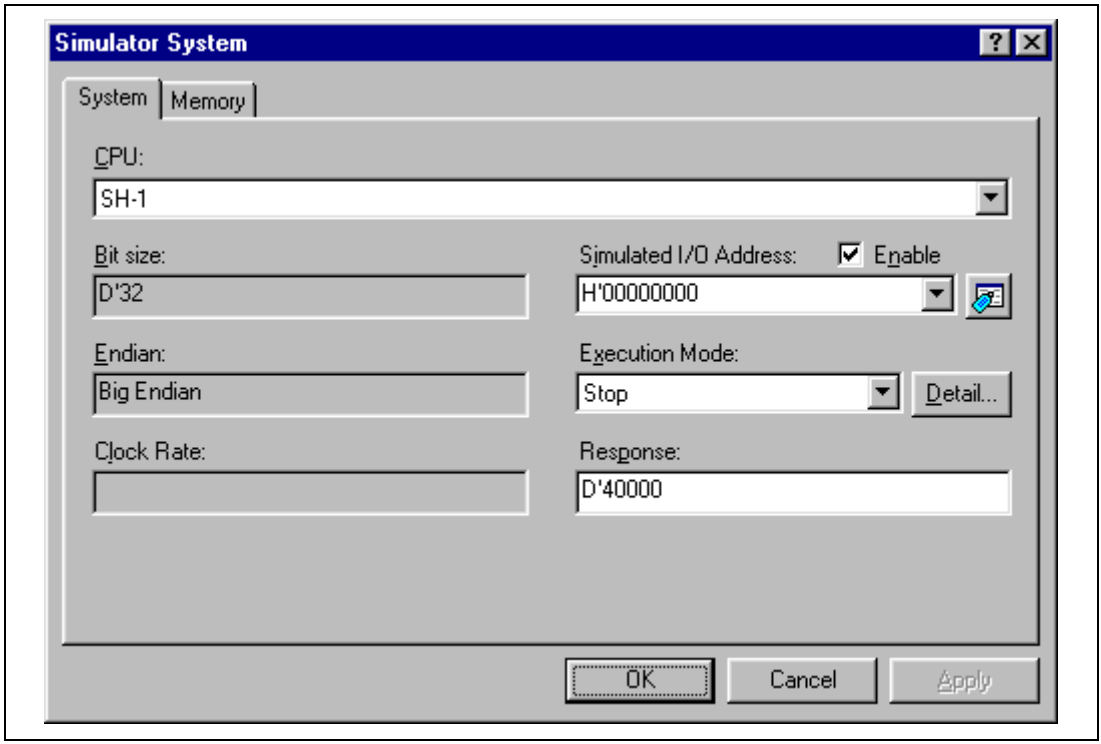


Figure 7.6 Simulator System Dialog Box (System Page)

- Confirm that [Enable] of [Simulated I/O Address] is checked.
- Click the [OK] button to enable the simulated I/O.
- Select [Simulated I/O] from the [View->CPU] menu and open the [Simulated I/O] window. The simulated I/O will not be enabled if the [Simulated I/O] window is not open.

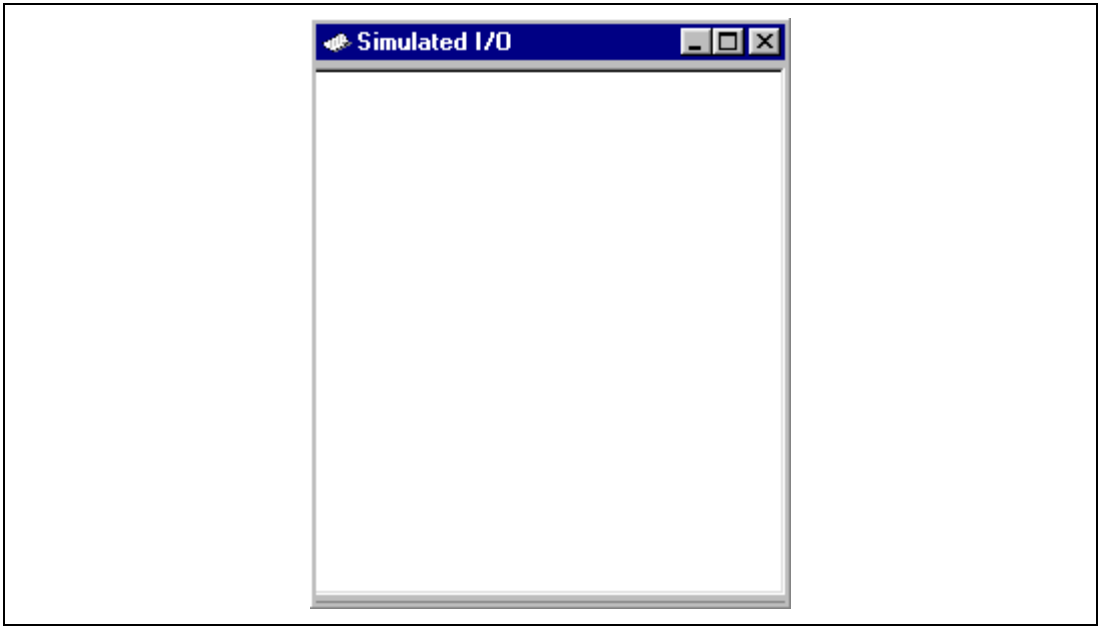


Figure 7.7 Simulated I/O Window

7.2.7 Setting the Trace Information Acquisition Conditions

- Select [Trace] from the [View->Code] menu to open the [Trace] window. Open the pop-up menu by right clicking the mouse on the [Trace] window, and select [Acquisition...] from the pop-up menu.

The [Trace Acquisition] dialog box below will be displayed.

Figure 7.8 Trace Acquisition Dialog Box

- Set [Trace Start/Stop] to [Enable] in the [Trace Acquisition] dialog box, and click the [OK] button to enable the acquisition of the trace information.

7.2.8 Setting the Stack Pointer and Program Counter

To execute the program, the program counter must be set from the location of the reset vector. In the reset vector of the sample program, the PC value H'800 is written, and the SP value H'0FFFFFF0 is written.

- Select [Reset CPU] from the [Debug] menu, or click the [Reset CPU] button on the toolbar.

Set the program counter to H'800, and the stack pointer to H'0FFFFFF0 from the reset vector.

Figure 7.9 Reset CPU Button

7.3 Start Debugging

7.3.1 Executing a Program

- Select [Go] from the [Debug] menu, or click the [Go] button on the toolbar.

Figure 7.10 Go Button

The program halts where a breakpoint is set. An arrow is displayed in the [Source] window, indicating the location the execution has stopped. As the termination cause, [PC Breakpoint (PC: H'000013F8)] is displayed in the [Output] window.

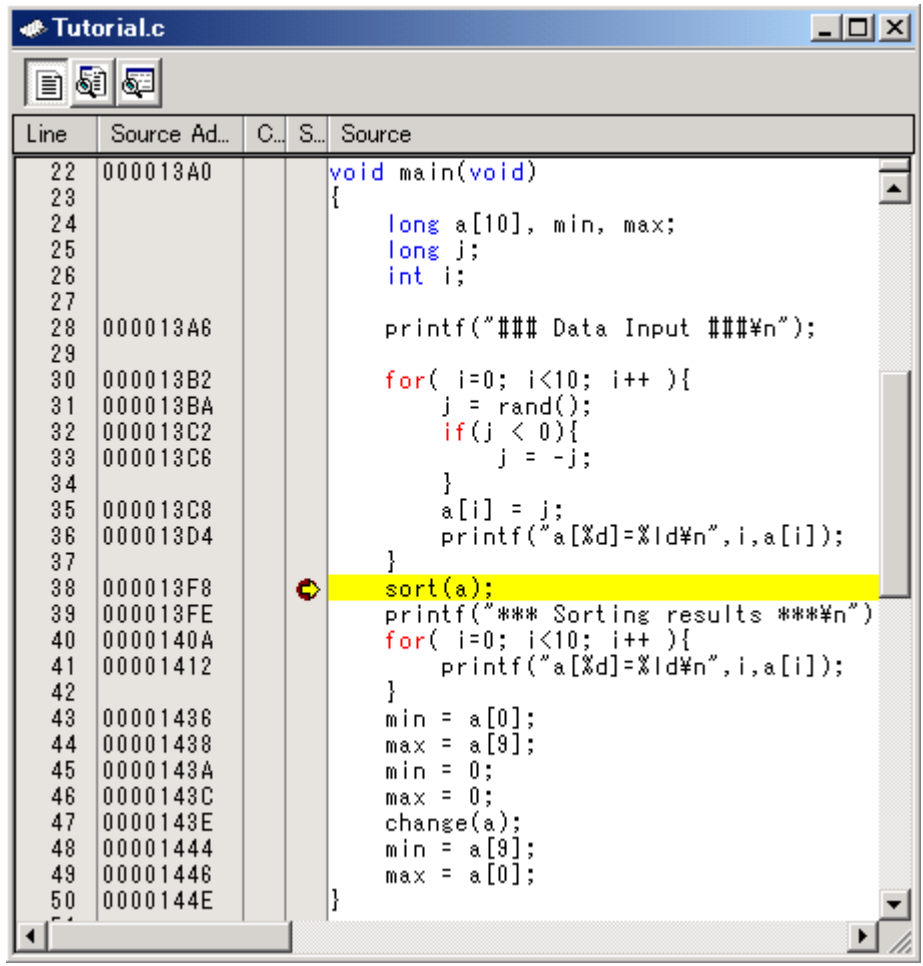


Figure 7.11 Source Window (Break Status)

The termination cause can be displayed in the [Status] window.

- Select [Status] from the [View->CPU] menu to open the [Status] window, and select the [Platform] sheet in the [Status] window.

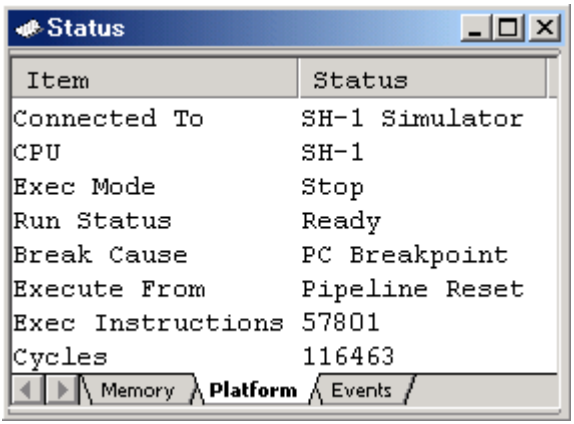


Figure 7.12 Status Window

The above status window indicates that:

(1) The cause of break is a PC breakpoint
(2) Execution is performed from the pipeline reset
(3) The number of executed instructions by the GO command is 57,801
(4) The executed number of cycles from the pipeline reset is 116,463

Register values can be checked in the [Register] window.

- Select [Registers] from the [View->CPU] menu.

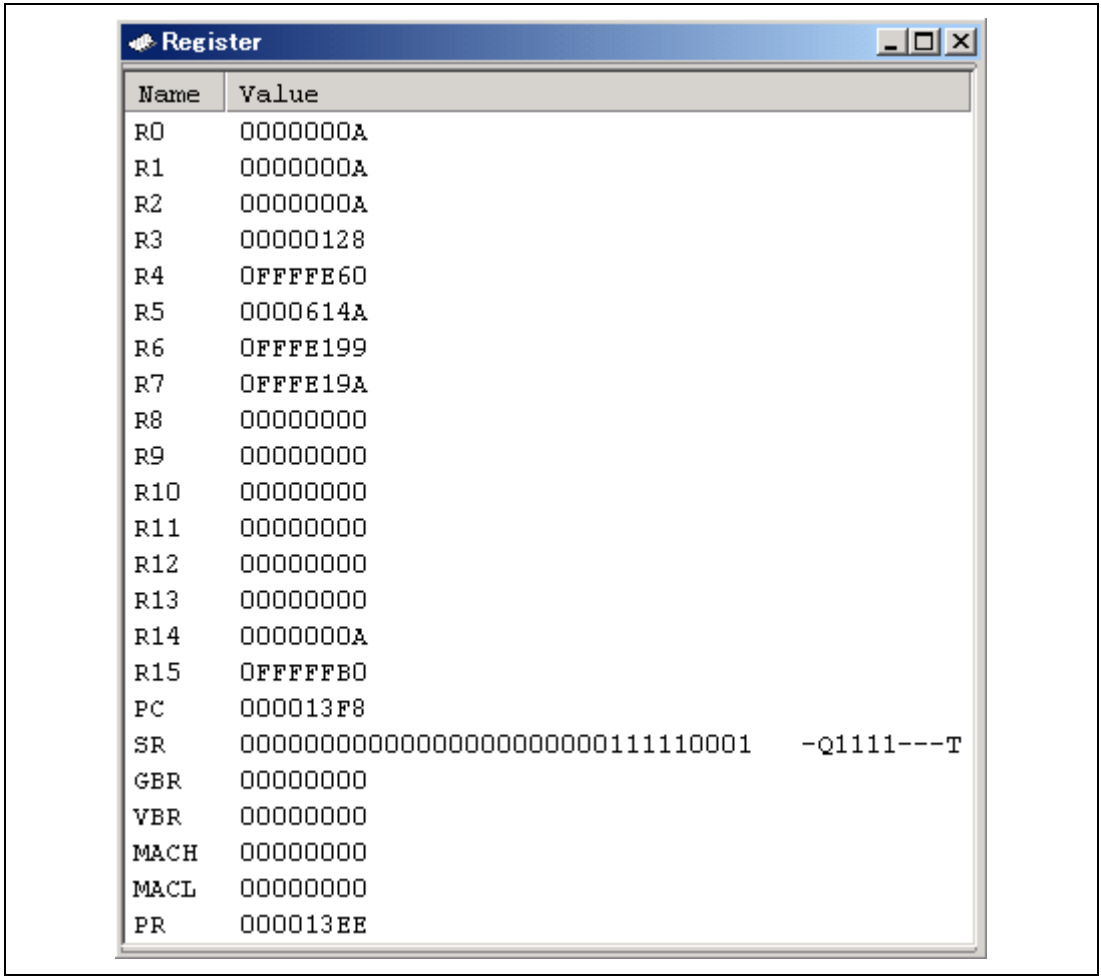


Figure 7.13 Register Window

Register values when the program is terminated can be checked.

7.3.2 Using the Trace Buffer

The trace buffer can be used to clarify the history of instruction execution.

- Select [Trace] from the [View->Code] menu to open the [Trace] window. Scroll up to the very top of the window.

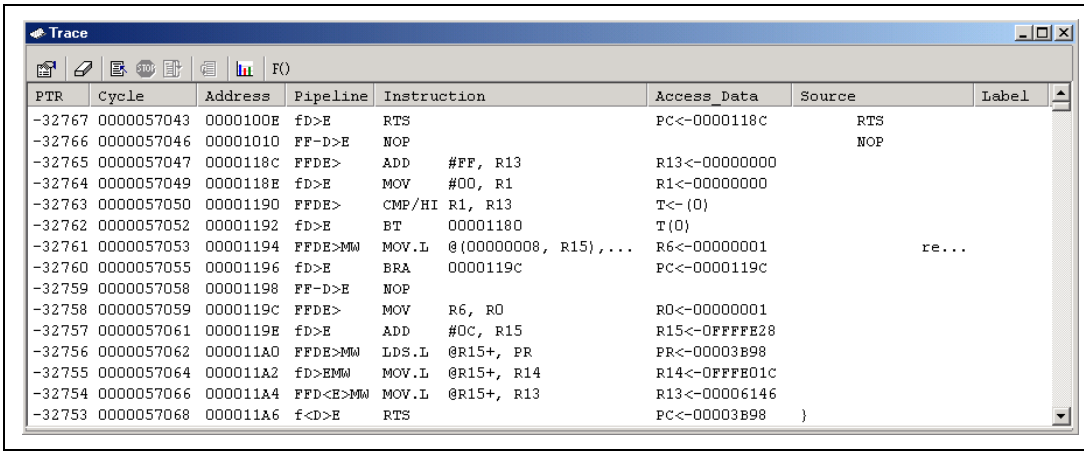


Figure 7.14 Trace Window (Trace Information Display)

7.3.3 Performing Trace Search

Click the right mouse button on the [Trace] window to launch the pop-up menu, and select [Find...] to open the [Trace Search] dialog box.

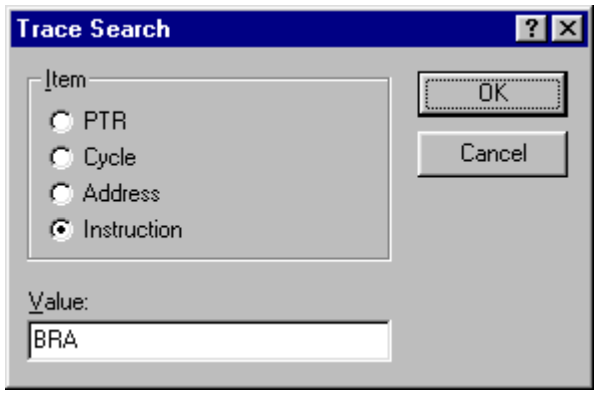
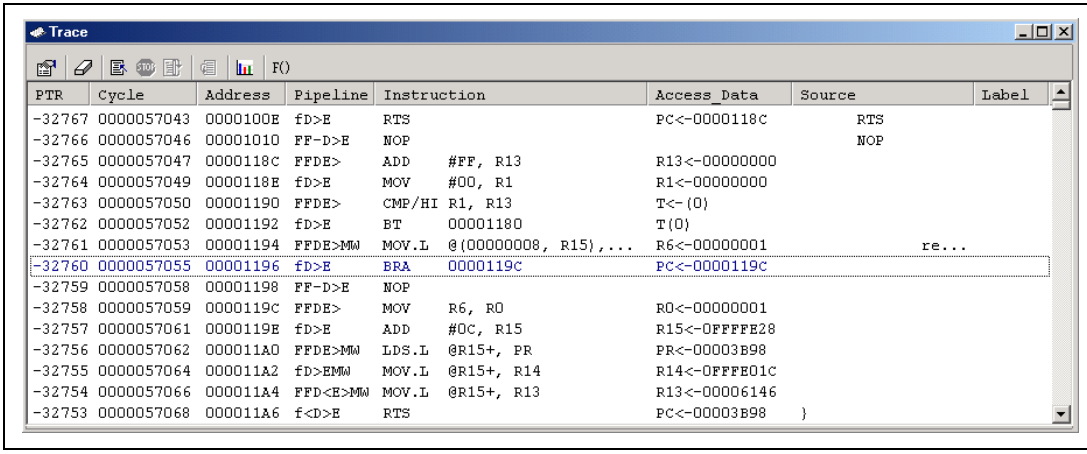


Figure 7.15 Trace Search Dialog Box

Setting the item to be searched to [Item] and the contents to be searched to [Value] and clicking the [OK] button begins the trace search. When the searched item is found, the first line is highlighted. To continue searching the same contents [Value], click the right mouse button in the [Trace] window to display the pop-up menu, and select [Find Next] from the pop-up menu. The next searched line is highlighted.



PTR	Cycle	Address	Pipeline	Instruction	Access_Data	Source	Label
-32767	0000057043	0000100E	fD>E	RTS	PC<-0000118C	RTS	
-32766	0000057046	00001010	FF-D>E	NOP		NOP	
-32765	0000057047	0000118C	FFDE>	ADD #FF, R13	R13<-00000000		
-32764	0000057049	0000118E	fD>E	MOV #00, R1	R1<-00000000		
-32763	0000057050	00001190	FFDE>	CMP/HI R1, R13	T<-(0)		
-32762	0000057052	00001192	fD>E	BT 00001180	T(0)		
-32761	0000057053	00001194	FFDE>MW	MOV.L @(00000008, R15),...	R6<-00000001	re...	
-32760	0000057055	00001196	fD>E	BRA 0000119C	PC<-0000119C		
-32759	0000057058	00001198	FF-D>E	NOP			
-32758	0000057059	0000119C	FFDE>	MOV R6, R0	R0<-00000001		
-32757	0000057061	0000119E	fD>E	ADD #0C, R15	R15<-0FFFFE28		
-32756	0000057062	000011A0	FFDE>MW	LDS.L @R15+, PR	PR<-00003B98		
-32755	0000057064	000011A2	fD>EMW	MOV.L @R15+, R14	R14<-0FFFE01C		
-32754	0000057066	000011A4	FFD<E>MW	MOV.L @R15+, R13	R13<-00006146		
-32753	0000057068	000011A6	f<D>E	RTS	PC<-00003B98	}	

Figure 7.16 Trace Window (Searched Result)

7.3.4 Checking Simulated I/O

Random data that is displayed by the printf function can be checked in the [Simulated I/O] window.

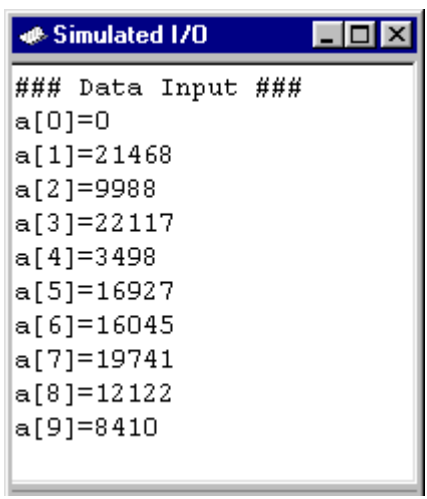


Figure 7.17 Simulated I/O Window

- Do not close the [Simulated I/O] window.

7.3.5 Checking the Breakpoints

A list of all the breakpoints that are set in the program can be checked in the [Event] window.

- Select [Eventpoints] from the [View -> Code] menu.

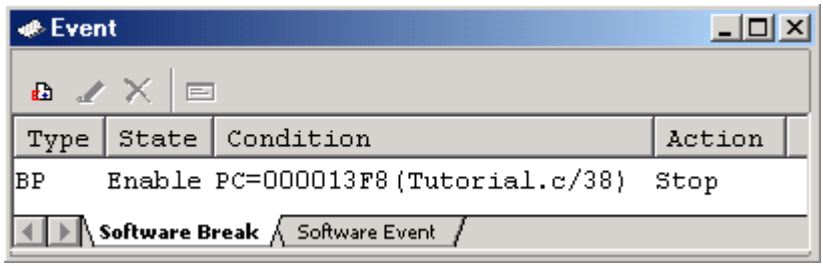


Figure 7.18 Event Window

A breakpoint can be set, a new breakpoint can be defined, and a breakpoint can be deleted using the [Event] window.

- Close the [Event] window.

7.3.6 Watching Variables

It is possible to watch the values of variables used in your program and to verify that they change in the way that you expected. For example, set a watch on the long-type array "a" declared at the beginning of the program, by using the following procedure:

- Select [Watch] from the [View -> Symbol] menu to open the [Watch] window. And click the right mouse button on the [Watch] window and choose [Add Watch...] from the pop-up menu.

The following dialog box will be displayed.

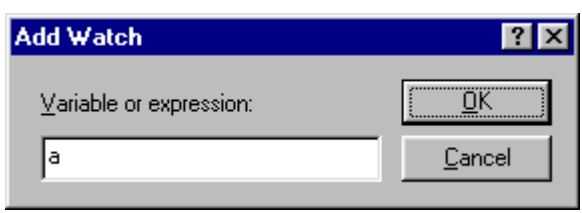


Figure 7.19 Add Watch Dialog Box

- Type array "a" and click the [OK] button.

The [Watch] window will show the long-type array "a".
You can double-click the + symbol to the left of array "a" in the [Watch] window to expand the variable and show the individual elements in the array.

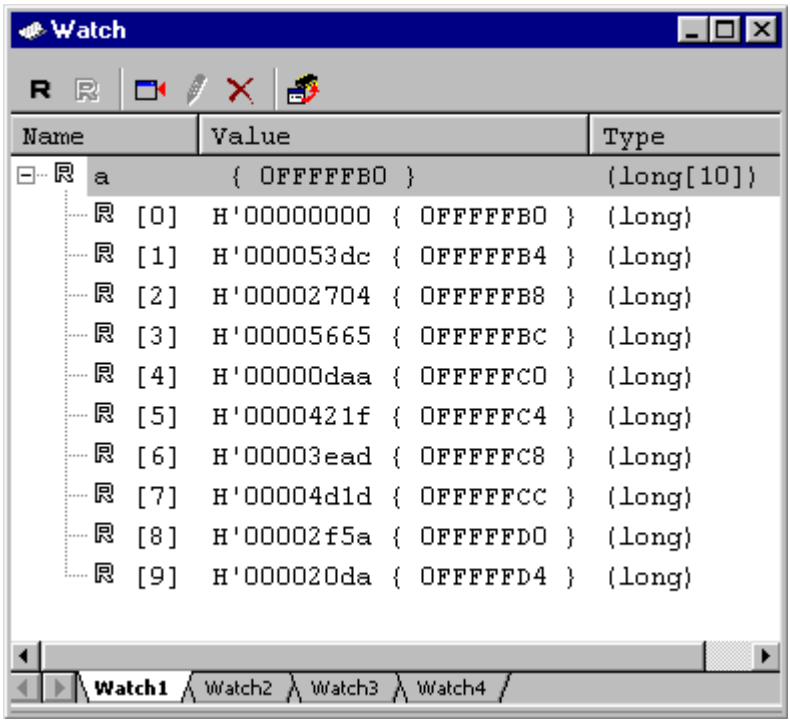


Figure 7.20 Watch Window

- Close the [Watch] window.

7.3.7 Executing the Program in Single Steps

The simulator/debugger has various stepping menus that are useful in debugging the program.

Menu	Description
Step In	Executes each statement (includes statements within the function)
Step Over	Executes a function call in a single step
Step Out	Steps out of a function, and stops at the next statement of the program that called the function
Step...	Executes the specified number of steps at the specified speed

[Step In]: Enters the called function and stops at the statement at the start of the called function.

- To step in the sort function, select [Step In] from the [Debug] menu, or click the [Step In] button on the toolbar.

Figure 7.21 Step In Button

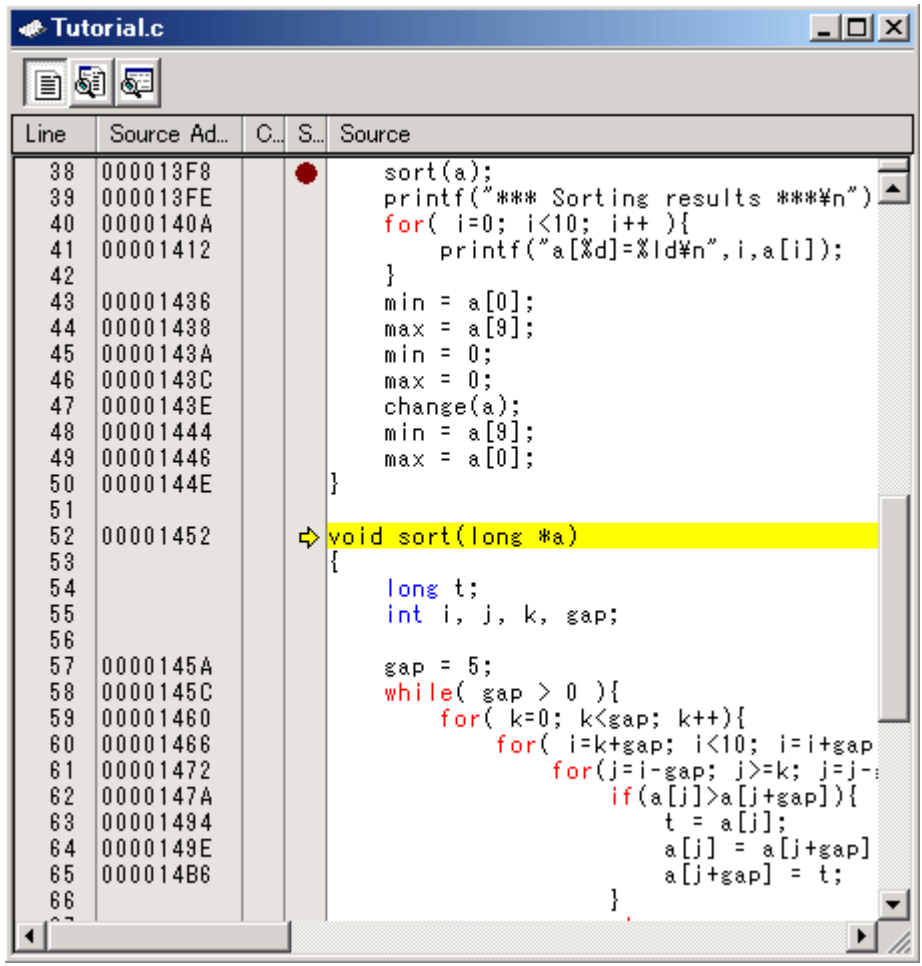


Figure 7.22 Source Window (Step In)

- The PC location display (=>) in the [Source] window moves to the statement at the start of the sort function.

[Step Out]: Steps out of the called function and stops at the next statement in the called program.

- Select [Step Out] from the [Debug] menu to exit the sort function, or click the [Step Out] button on the toolbar.

Figure 7.23 Step Out Button

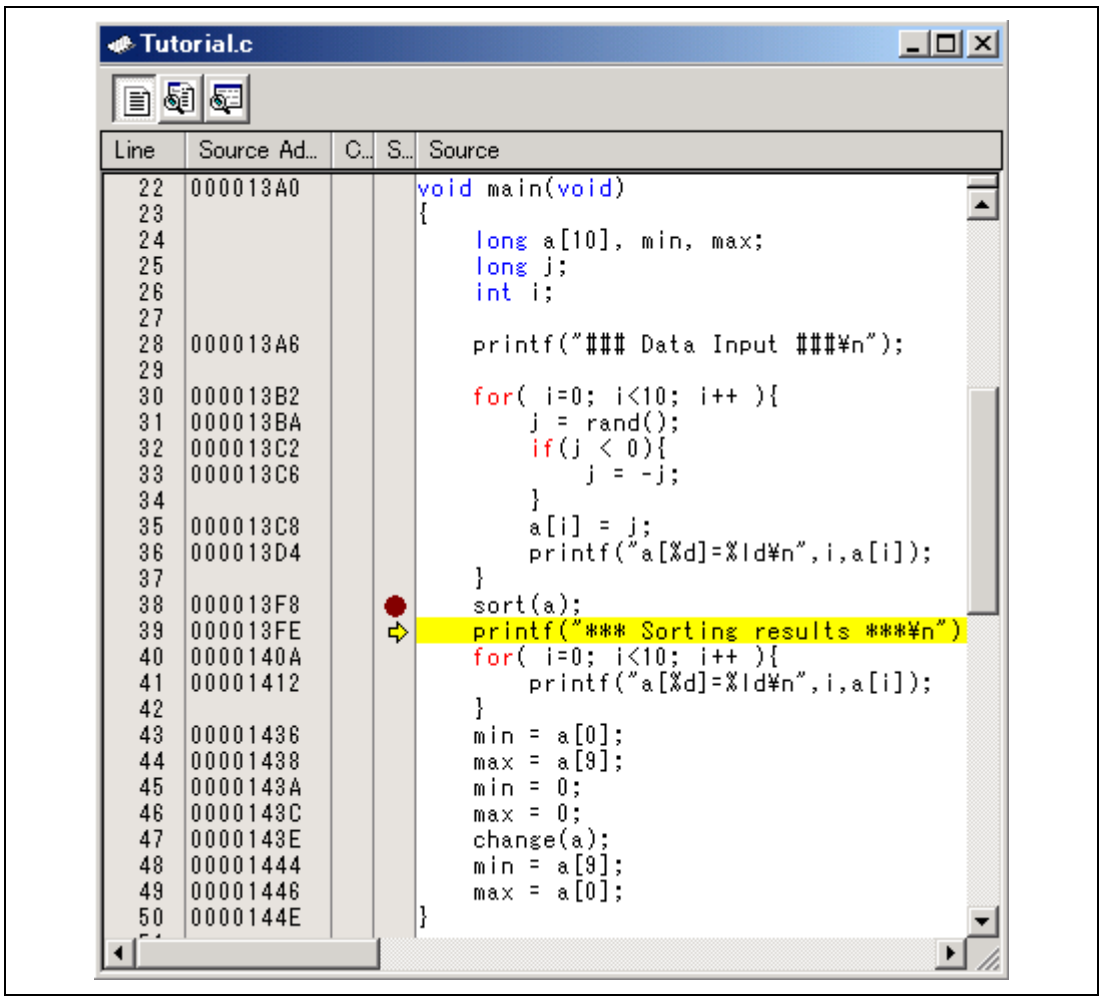


Figure 7.24 Source Window (Step Out)

[Step Over]: Executes a function call in a single step, and stops at the next statement in the main program.

Select [Step Over] from the [Debug] menu or click the [Step Over] button on the toolbar to step over the statements in the printf function.

Figure 7.25 Step Over Button

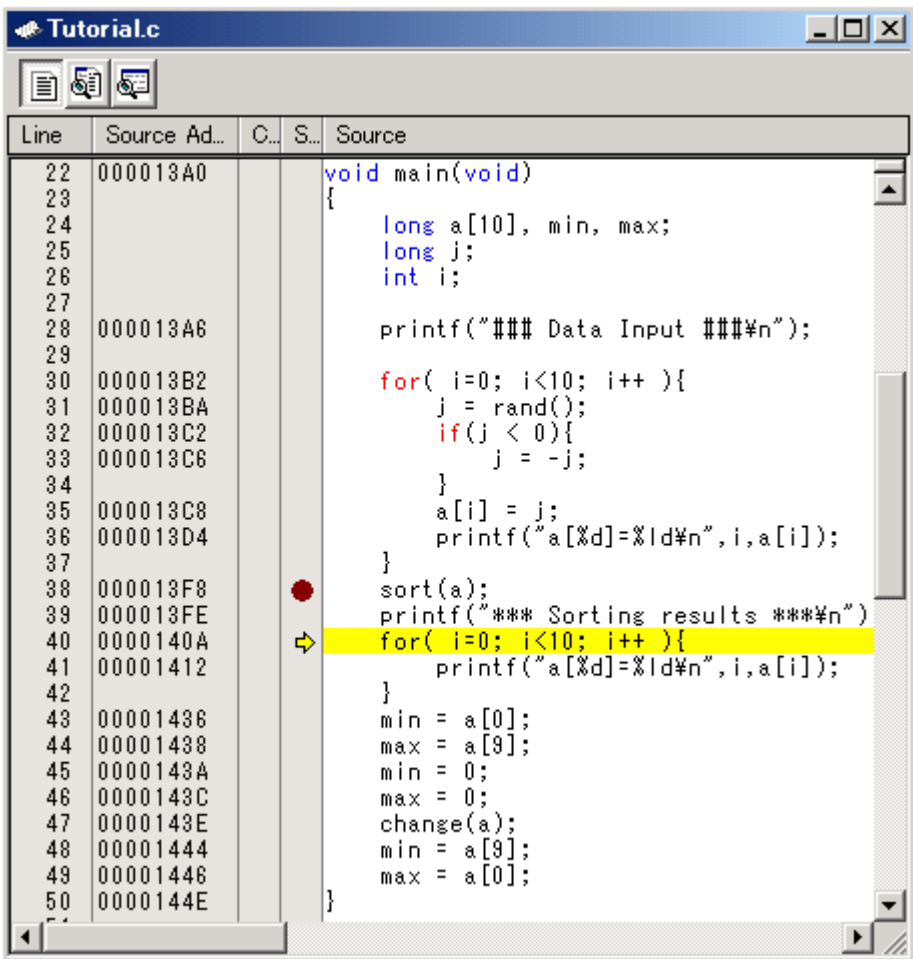


Figure 7.26 Source Window (Step Over)

When the printf function has been executed, *** Sorting results *** will be displayed in the [Simulated I/O] window.

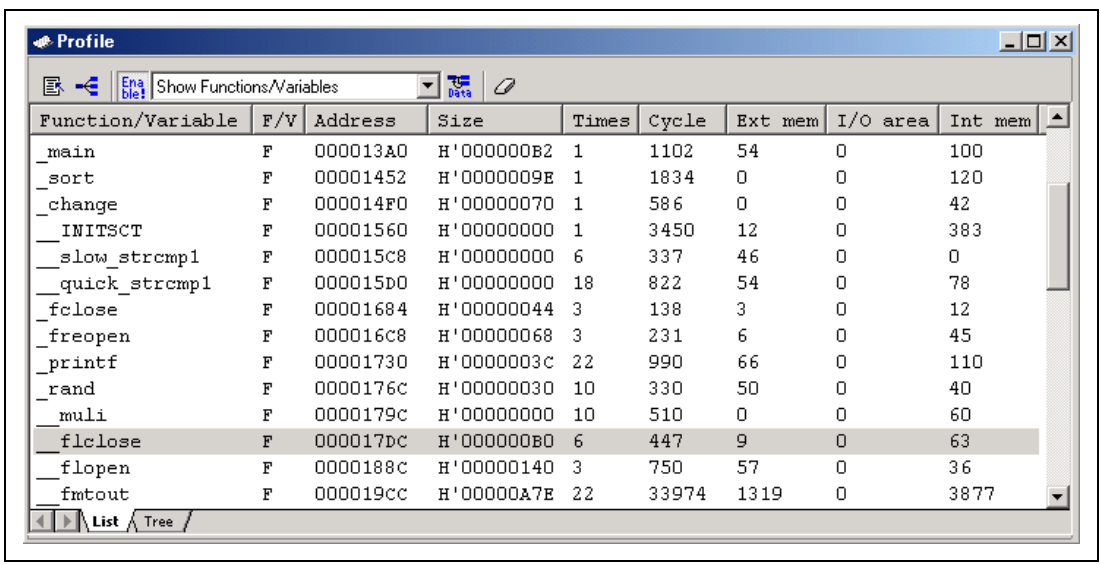
7.3.8 Checking Profile Information

The profile information can be checked in the [Profile] window.

- Clicking the [Go] button and continuing execution from the current PC executes the SLEEP instruction and then stops.

[List] Sheet: Displays the profile information as a list.

- Open the [Profile] window by selecting [Profile] from the [View->Performance] menu. The [List] sheet will be displayed.



Function/Variable	F/V	Address	Size	Times	Cycle	Ext mem	I/O area	Int mem
_main	F	000013A0	H'000000B2	1	1102	54	0	100
_sort	F	00001452	H'0000009E	1	1834	0	0	120
_change	F	000014F0	H'00000070	1	586	0	0	42
__INITSCT	F	00001560	H'00000000	1	3450	12	0	383
__slow_strcmp1	F	000015C8	H'00000000	6	337	46	0	0
__quick_strcmp1	F	000015D0	H'00000000	18	822	54	0	78
_fclose	F	00001684	H'00000044	3	138	3	0	12
_freopen	F	000016C8	H'00000068	3	231	6	0	45
_printf	F	00001730	H'0000003C	22	990	66	0	110
_rand	F	0000176C	H'00000030	10	330	50	0	40
__muli	F	0000179C	H'00000000	10	510	0	0	60
__flclose	F	000017DC	H'000000B0	6	447	9	0	63
__flopen	F	0000188C	H'00000140	3	750	57	0	36
__fmtout	F	000019CC	H'00000A7E	22	33974	1319	0	3877

Figure 7.27 Profile Window (List Sheet)

In the above figure, it can be found that the __flclose function was called six times, the execution cycle was 447, the external memory was accessed nine times, and the internal memory was accessed 63 times.

It is possible to search for the critical path, such as a function that is called or accesses the memory many times, for the program performance.

[Tree] Sheet: Displays the profile information as a tree diagram.

- Select the [Tree] sheet. Double-clicking the function name in the [Profile] window expands or minimizes the tree structure.

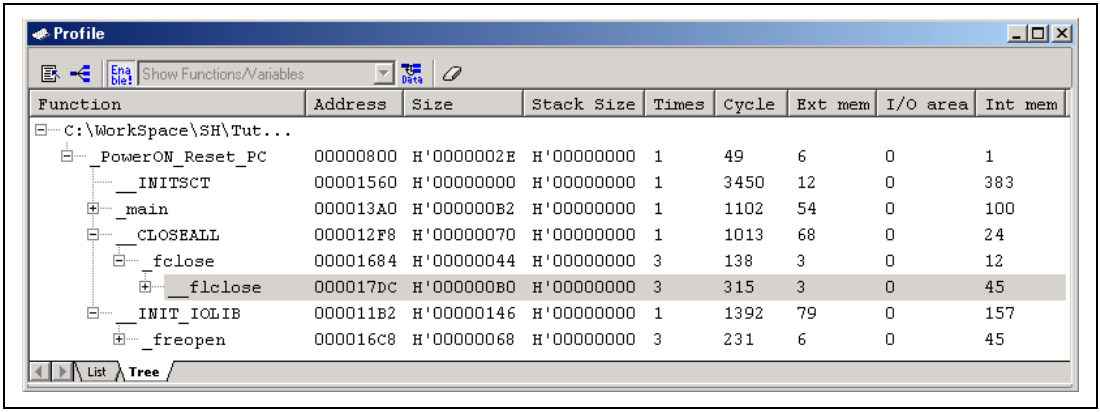


Figure 7.28 Profile Window (Tree Sheet)

In above figure, it can be found that the __flclose function was called three times from the _fclose function, the execution cycle was 315, the external memory was accessed three times, and the internal memory was accessed 45 times.

[Profile-Chart] Window: Displays the relation of calls for a specific function.

- Select the __flclose function on the [Profile] window. Open the pop-up menu by right clicking the mouse on the [Profile] window, and select [View Profile-Chart] to display the [Profile-Chart] window.

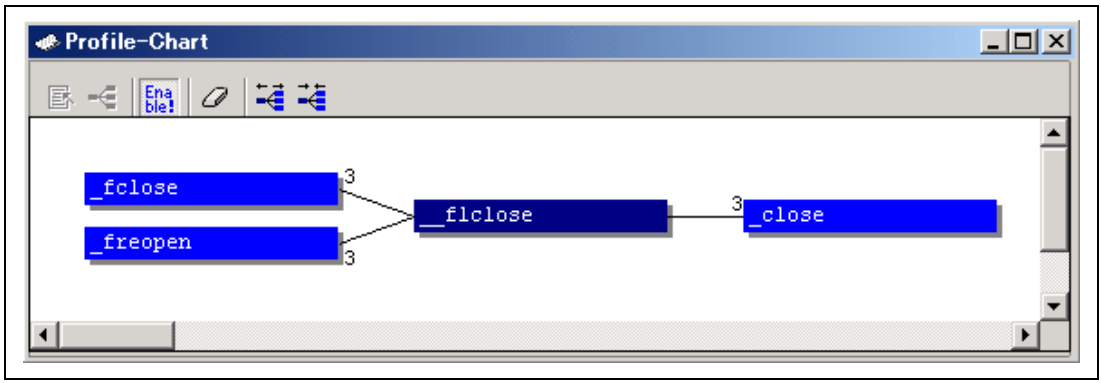


Figure 7.29 Profile-Chart Window

In the above figure, it can be found that the __flclose function was called three times from the _fclose and _freopen functions, and the _close function was called three times.

This is the end of the tutorial using the simulator/debugger.

Renesas Microcomputer Development Environment System
User's Manual
SuperH™ RISC engine Simulator/Debugger

Publication Date:	Rev.4.00, July 25, 2007
Published by:	Sales Strategic Planning Div. Renesas Technology Corp.
Edited by:	Customer Support Department Global Strategic Communication Div. Renesas Solutions Corp.

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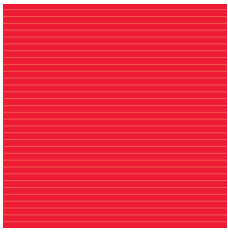
SuperH™ RISC engine Simulator/Debugger User's Manual



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